Texas ST-Elevation Myocardial Infarction (STEMI) and Heart Attack System of Care Report, 2018

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Contents

I. EXECUTIVE SUMMARY

The prevalence of heart attack in Texas has remained steady over the last few years, affecting about 4% of the adult resident population each year, from 2011 to 2016 (Table 1). In order to advance heart attack reduction efforts, it is important to analyze the system of care, specifically for ST-Elevation Myocardial Infarction (STEMI), by collecting and analyzing data. During the 83rd Regular Texas Legislative Session, funds were appropriated to advance heart attack and stroke reduction efforts throughout Texas. To inform such efforts, the Texas Department of State Health Services (DSHS) has launched a Heart Attack and Stroke Data Collection Initiative.

Utilizing the time to treatment goals for primary percutaneous coronary intervention (PCI) and standards of care, percentages and medians were calculated using data collected from a group of hospitals that agreed to voluntarily participate in this data collection initiative. The data were collected by the Acute Coronary Treatment and Intervention Outcomes Network (ACTION) Registry, a program of the American College of Cardiology in partnership with the American Heart Association and other societies, from September 1, 2008 through December 31, 2017. Currently, 116 PCI-capable hospitals are participating in the ACTION Registry in Texas. In 2017, when the highest number of hospitals were reporting for each measure, at most 48 out of these 116 PCI-capable hospitals were included (41.4%).

Substantial findings from the 2008-2017 ACTION Registry data are as follows:

- 48 hospitals, distributed across 31 cities in Texas, provided data on individual episodes of care for heart attack. Most participating hospitals were located in urban or suburban communities; only seven were located in rural communities (pgs. 11-12).
- 57,127 individual episodes of care for heart attack occurred among 54,545 patients at participating hospitals (pg. 13).
- Of the 57,127 episodes of care for heart attack that occurred:
    - 60.0% involved patients who either transported themselves or were transported by family to the hospital where they were first evaluated (pg. 13);
    - 38.9% arrived to the hospital by an ambulance (pg. 13);
        - More males (61.9%) than females (56.6%) were transported via ambulance (pg. 14);
        - More males 63.0%) than females (56.0%) received an electrocardiogram (ECG) prior to hospital arrival (pg. 14); and
        - Fewer White or Hispanic cases arrived by ambulance as compared with Black cases (38.0%, 34.3%, and 45.4%, respectively) (pg. 15);
    - 74.6% involved patients receiving their first ECG upon arriving at the hospital;
    - 32.0% involved care for STEMI (pg. 11).
- The median length of hospital stay each year between 2008 and 2017 was three days. The mean length of hospital stay in 2017 was 4.1 days (pg. 13).
- Among patients who arrived by an ambulance between 2008 and 2017, only 60.4% had a pre-hospital electrocardiogram (ECG) performed. This was an improvement since 2016, when only 51.3% had a pre-hospital ECG. In 2017, among those who had

pre-hospital ECG performed, 79.1% had their pre-hospital ECG performed within 10 minutes of first medical contact (pgs. 17-22)

- Between October 2008 and December 2017, the median time spent awaiting transfer from the STEMI referral hospital to the STEMI receiving hospital for PCI was 45.5 minutes for those who arrived by personal vehicle and 50.0 minutes for those who arrived by ambulance (pg. 23).
- Among directly-admitted STEMI cases, the annual median dwell time in the Emergency Department (ED) was, on average, 10-15 minutes longer for those arriving via personal vehicle than via ambulance (pg. 25).
- From 2011 to 2017, the median time from arrival at the referral hospital to primary PCI among STEMI transfer cases transported via private vehicle has increased by five minutes (94 minutes to 99 minutes). In contrast, this has more than doubled among STEMI transfer cases transported via ambulance, from 67 minutes to 148.5 minutes (pgs. 28-30).
- In 2017, the median time from first medical contact to balloon was 75 minutes for directly-admitted cases and 190.5 minutes for transfer cases (pg. 33).
- Total ischemic time among STEMI transfer cases was calculated for 2011-2017:
    - Among those who arrived by ambulance at the first hospital, 18.7% had a total ischemic time of less than 120 minutes, while among those who arrived at the first hospital by personal vehicle, 11.4% had a total ischemic time of less than 120 minutes (pg. 35).
    - Among directly-admitted cases arriving by ambulance in 2017, 44.1% had a total ischemic time of less than 120 minutes, as compared with 25.2% who arrived by personal vehicle (pg. 36).
- In 2017, among 257 STEMI transfer cases who arrived at the first hospital either by a personal vehicle or by an ambulance, the catheterization lab was activated prior to arrival for 45.5% of cases (pg. 38).
- In 2017, among 717 directly-admitted STEMI cases who arrived at the hospital by ambulance, pre-catheterization lab activation occurred for 56.8% of cases (pg. 39).
- Between 2008 and 2017, the percentage of comorbidities among Myocardial Infarction (MI) cases was evaluated. Of the 54,041 MI cases having information on comorbidities, 77.9% were hypertensive, 61.0% were dyplipidemic, 42.4% were obese, 40.1% were diabetic, and 30.5% were current or recent smokers (pg. 42).
- Of 57,127 MI cases seen between 2008 and 2017, 95.7% were prescribed aspirin within the first 24 hours of either first medical contact or hospital arrival, 2.2% were not prescribed aspirin, and 2.0% had contraindications to aspirin use (pg. 46).
- Of 57,127 MI cases seen between 2008 and 2017, beta-blockers were prescribed for 80.8% at discharge, not prescribed for 2.6%, contraindicated for 5.4%, and data were missing for 11.3% of cases (pg. 48).
- Between 2008 and 2017, the unadjusted in-hospital mortality rates in STEMI patients ranged from as low as 5.3% in 2008 to as high as 7.2% in 2013; mortality rates for STEMI patients are consistently double those of non-STEMI patients (pg. 52).

II. INTRODUCTION

When blood flow through the heart's arteries is blocked, the heart is starved of oxygen and heart cells die. This is called a myocardial infarction (MI) or heart attack. [1] A STEMI is a serious type of heart attack that occurs when a heart's artery is completely blocked and a large part of the heart muscle is unable to receive blood. [1] This type of heart attack requires immediate treatment to restore blood flow to the heart.

III. BACKGROUND

In order to advance heart attack reduction efforts, it is important to analyze the system of care, specifically for STEMI, by collecting and analyzing data. During the 83rd Regular Texas Legislative Session, funds were appropriated to advance heart attack and stroke reduction efforts throughout Texas. To inform such efforts, the Texas Department of State Health Services (DSHS) has launched a Heart Attack and Stroke Data Collection Initiative. Through this initiative, hospitals are recruited to voluntarily share their data that focuses on pre-hospital and hospital data elements. This report includes de-identified, aggregate data for hospitals that have agreed to share Acute Coronary Treatment and Intervention Outcomes Network (ACTION) Registry data with DSHS. All data are intended to inform stakeholders about opportunities for collaboration and system enhancement. No hospital level data will be distributed, nor will any hospital name be identified in the report.

The objectives of the data collection are to gain an understanding of the prevalence of heart attack in Texas, to evaluate pre-hospital components of the systems of care, and assess treatment of heart attack patients. The findings will be used to assess policies and practices regarding delivery of care across the state and to identify areas of opportunity for quality improvement.

IV. HEART ATTACK IN TEXAS

The prevalence of heart attack in Texas has remained steady over the last few years, affecting about 4% of the adult resident population each year from 2011 to 2016 (Table 1). In 2016, the prevalence of heart attack was significantly higher among non-Hispanic white adults (4.9%; 95% CI: 4.0-5.8) compared to Hispanic adults (1.9%; 95% CI: 1.2-2.6).

Table 1. Estimated number and percentage of adults in Texas, ages 18 years and older, who report ever having had a heart attack, by race/ethnicity, 2011-2016.

	Estimated Cases		Race/Ethnicity % (95% CI)			
Year	(N)	% (95% CI)	White Only	Black Only	Hispanic	Other / Multiracial
2011	740,234	4.1 (3.6-4.5)	4.6 (4.0-5.2)	4.6 (2.4-6.7)	2.9 (2.2-3.7)	4.2 (2.1-6.2)
2012	718,735	3.8 (3.3-4.2)	4.3 (3.7-4.9)	4.3 (2.7-5.9)	2.4 (1.7-3.1)	4.9 (2.3-7.5)
2013	763,932	3.9 (3.4-4.5)	4.4 (3.7-5.2)	6.2 (3.9-8.5)	2.6 (1.9-3.3)	--
2014	729,812	3.7 (3.2-4.1)	4.7 (4.1-5.4)	4.1 (2.2-6.0)	2.4 (1.8-3.0)	--
2015	862,314	4.3 (3.7-4.8)	5.0 (4.2-5.9)	5.3 (2.8-7.9)	2.9 (2.2-3.7)	--
2016	741,515	3.6 (3.0-4.2)	4.9 (4.0-5.8)	--	1.9 (1.2-2.6)	--

Abbreviations: CI, confidence interval.
-- indicates data are not reportable due to small sample size.

However, using MI hospitalization rates as an approximation of the incidence of disease, the overall rate of MI has decreased since 2008, from 17.6 per 10,000, to 15.8 per 10,000 in 2016 (Table 2). Rates among whites, blacks, and "other" have shown a trend over time, with an increase in 2015 and 2016. The MI hospitalization rate among Hispanics was significantly lower as compared to other race/ethnic groups, each year through 2015. In 2015 and 2016, however, the Hispanic rate was no longer lower as compared to Whites, but was still lower as compared to Blacks. MI hospitalization rate for "other" race has fluctuated over the years, reaching a peak in 2012.

Table 2. Annual age-adjusted hospitalization rate (per 10,000) for heart attack among persons of all ages in Texas, by race/ethnicity, 2008-2016.

			Race/Ethnicity % (95% CI)			
Year	N	Age-adjusted Rate (95% CI)	White	Black	Hispanic	Other
2008	36,983	17.6 (17.4-17.8)	18.0 (17.8-18.2)	17.8 (17.2-18.4)	14.7 (14.3-15.0)	35.0 (33.7-36.4)
2009	34,606	16.1 (15.9-16.2)	16.4 (16.2-16.6)	16.3 (15.8-16.9)	13.4 (13.1-13.8)	28.7 (27.6-29.9)
2010	35,675	16.0 (15.8-16.1)	16.0 (15.8-16.2)	16.2 (15.7-16.8)	14.2 (13.9-14.5)	30.7 (29.4-31.9)
2011	35,878	15.5 (15.4-15.7)	15.9 (15.7-16.1)	16.1 (15.6-16.7)	13.0 (12.7-13.3)	25.9 (24.9-27.0)
2012	37,911	15.9 (15.7-16.0)	15.1 (14.9-15.9)	15.4 (14.9-15.9)	13.9 (13.6-14.2)	40.1 (38.9-41.4)
2013	37,287	15.2 (15.0-15.3)	15.1 (14.9-15.3)	15.4 (14.9-15.9)	13.5 (13.2-13.8)	25.6 (24.7-26.6)
2014	38,304	14.7 (14.6-14.9)	14.6 (14.4-14.7)	15.0 (14.6-15.5)	13.5 (13.2-13.8)	25.6 (24.6-26.5)
2015	41,901	15.6 (15.4-15.7)	15.6 (15.4-15.8)	16.1 (15.6-16.6)	14.8 (14.5-15.1)	21.6 (20.8-22.5)
2016	44,005	15.8 (15.6-15.9)	15.5 (15.3-15.7)	15.9 (15.5-16.4)	15.1 (14.8-15.4)	25.7 (24.8-26.6)

Abbreviations: CI, confidence interval.

The age-adjusted heart attack mortality rate in Texas, 2015, was 38.0 per 100,000 (95% CI: 37.3-38.8). The 2015 age-adjusted heart attack mortality rate was significantly higher among blacks (41.5, 95% CI: 38.9-44.0) when compared with the overall Texas rate.

Looking at the geographic distribution of MI death rates over time, the highest rates are concentrated in counties located in east and northeast Texas (Figure 1).

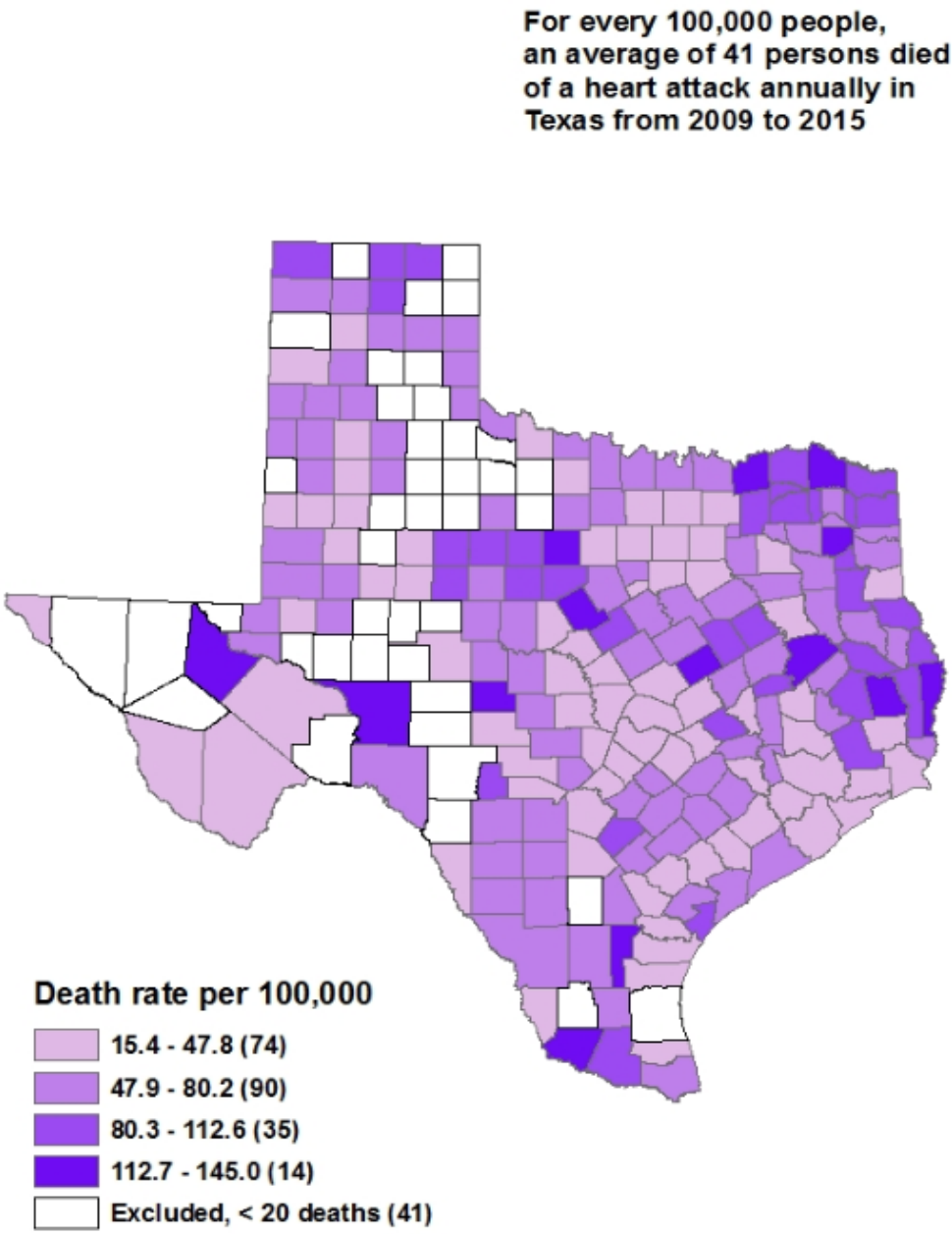

Figure 1. Age-adjusted average annual number of deaths due to heart attack, per 100,000 people of all ages, by county in Texas, 2009-2015.

V. EVALUATING HOSPITAL CARE FOR HEART ATTACK IN TEXAS

Percutaneous coronary intervention, PCI, is the preferred reperfusion strategy for STEMI patients. There are approximately 146 PCI-capable hospitals in Texas with a catheterization lab ready to perform PCI, 24 hours a day, 7 days a week. [2] These are often called "STEMI receiving hospitals." Hospitals that do not have this capability are often referred to as "STEMI referral hospitals"; STEMI patients who initially present at these hospitals must be transferred to a PCI-capable, STEMI receiving hospital. STEMI patients who first present to a STEMI receiving hospital are referred to as directly-admitted patients in this report, and STEMI patients who first report to a STEMI referral hospital and are then transferred to a

STEMI receiving hospital are referred to as transfer patients. Figure 2 illustrates the time to treatment goals for primary PCI for directly-admitted and for STEMI transfer patients. [3]

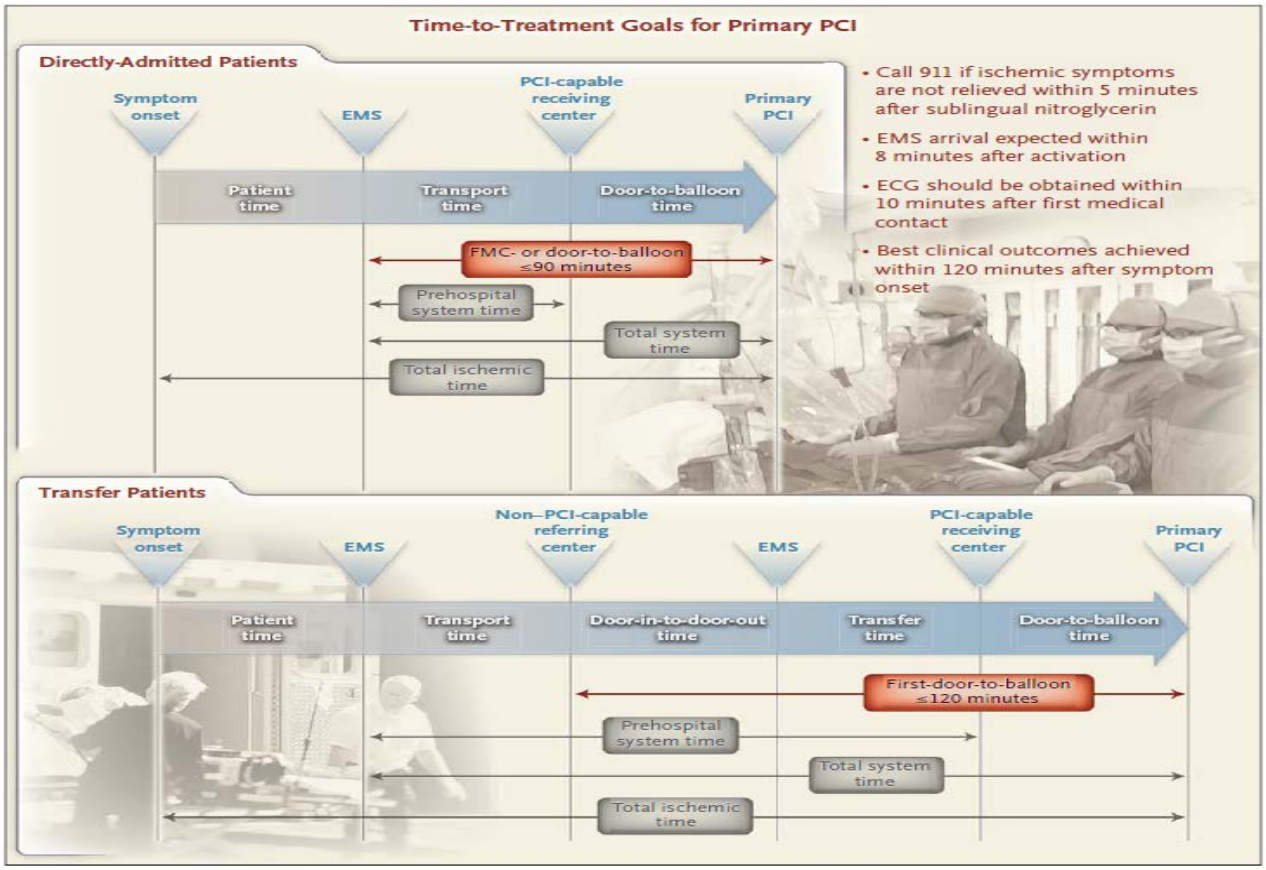

Figure 2. Time to treatment goals for primary PCI. [3]

Utilizing the time to treatment goals for primary PCI and standards of care, percentages and medians were calculated using data collected from a group of hospitals that volunteered to participate in this data collection initiative. The data were collected by the ACTION Registry from September 1, 2008 through December 31, 2017. Currently 134 PCI-capable hospitals are participating in the ACTION Registry. In 2017, when the highest number of hospitals were reporting for each measure, at most 48 out of these 134 PCI-capable hospitals were included (35.8%). General findings from these data are as follows:

- 48 participating hospitals, distributed across 31 cities in Texas, provided data on individual episodes of care for heart attack.
- The majority (n=41; 85.4%) of participating hospitals were located in urban or suburban communities, six (12.5%) of which were located in the city of Dallas; only seven participating hospitals (14.6%) were located in rural communities.
- 57,127 individual episodes of care for heart attack occurred among 54,540 patients at participating hospitals.
- Of the 57,127 episodes of care for heart attack that occurred:

- 60.0% involved cases who either transported themselves or were transported by family to the hospital where they were first evaluated;
- 74.6% involved cases receiving their first electrocardiogram (ECG) upon arriving at the hospital;
- 32.0% (n=18,298) involved care for STEMI;
- 83.3% had health insurance;
- 95.7% were alive at discharge.

Table 3 shows the number of participating hospitals and the number of reported heart attack cases from 2008 to 2017. The number of participating hospitals ranged from as few as 1 in 2008, to 48 in 2017. The number of reported heart attack cases has increased from a low of 96 in 2008 to a high of 9,308 in 2016, with n=8,897 reported in 2017.

Table 3. Participating hospitals and number of reported heart attack cases, 2008-2017.

Year	Participating Hospitals (N)	Reported Heart Attacks (N)
2008	1	96
2009	6	797
2010	23	3,294
2011	27	5,220
2012	35	6,451
2013	36	6,917
2014	42	7,800
2015	46	8,347
2016	48	9,308
2017	48*	8,897

* The actual number of participating hospitals is 51. One hospital system presents aggregate data for four of their hospitals. Data from these four hospitals cannot be analyzed individually, so they are counted as a single hospital in this report.

Table 4 displays the distribution of reported MI cases by subtype (STEMI vs non-STEMI). From 2008-2017, STEMI cases accounted for 32.0% of all reported MI cases.

Table 4. Distribution of reported heart attack cases, by subtype, 2008-2017.

Heart Attack Type	N=57,127	%
STEMI	18,298	32.0
Non-STEMI	38,829	68.0

Table 5 shows the demographic characteristics of MI cases reported between 2008 and 2017. Median age of all MI cases was 63 years. Almost two-thirds of the cases (65.2%) in the database were male (n=37,272).

Table 5. Demographic characteristics of heart attack cases in Texas, 2008-2017.

Characteristics	N (%)
Age (years)	
Median (Interquartile Range)	63 (18)
Gender	
Male	37,272 (65.2)
Female	19,855 (34.8)
Race	
White	46,898 (82.1)
Black	7,462 (13.1)
Asian	1,197 (2.1)
American Indian	432 (0.8)
Native Hawaiian	64 (0.1)
Multiracial	101 (0.2)
Missing	973 (1.7)
Ethnicity	
Hispanic	13,640 (23.9)
Non-Hispanic	43,278 (75.8)
Missing	209 (0.37)
Health Insurance Status	
Health insurance	47,605 (83.3)
No health insurance	9,522 (16.7)

Table 6 shows the number of hospitals and heart attack cases by urban vs. rural setting. With almost 90% of participating hospitals being in an urban setting, it is not surprising that most of the reported heart attack and STEMI cases were in the urban areas.

Table 6. Number of hospitals and heart attack cases, urban vs rural settings, 2008-2017.

Hospital setting	Reporting hospitals	Overall heart attack cases		STEMI cases	
	N	N	%	N	%
Urban	41	49,949	87.4	16,025	87.6
Rural	7	7,178	12.6	2,273	12.4
Total	48	57,127	100.0	18,298	100.0

Table 7 shows the number of heart attack cases by hospitals' patient bed capacity, by setting (urban vs. rural). The majority of heart attack cases (n=30,152) were admitted to hospitals with patient beds '100-349'. Hospitals with patient beds greater than 350 were found only in urban regions.

Table 7. Number of heart attack cases by hospital beds, by setting (urban, rural), 2008-2017.

Hospital beds	Overall heart attack cases (n)	STEMI cases (n)	Reporting Hospitals (n)
< 100	5,102	1,944	6 (5 urban, 1 rural)
100 -349	30,152	9,439	27 (21 urban, 6 rural)
350 -699	17,747	5,522	13 urban
≥ 700	4,126	1,393	2 urban
Total	57,127	18,298	48

The median length of hospital stay (LOS) was 3 days, each year, between 2008 and 2017. The mean LOS in 2017 was 4.1 days.

Arrival Method

According to the 2013 Texas Behavioral Risk Factor Surveillance System (BRFSS) survey, an estimated 86.9% of adults in Texas said they would call 911 if they thought someone was having a heart attack or stroke. The remaining 13.1% of adults said they would take other action such as taking the person to the hospital, telling them to call their doctor, call their spouse or family member, or do something else**.**

However, per the ACTION Registry data, 60.0% of heart attack patients transported themselves, or were transported by family/friend, via private vehicle, to the hospital, while 38.9% were transported by an ambulance. Among those who were transported by ambulance, only 60.4% had a pre-hospital ECG performed.

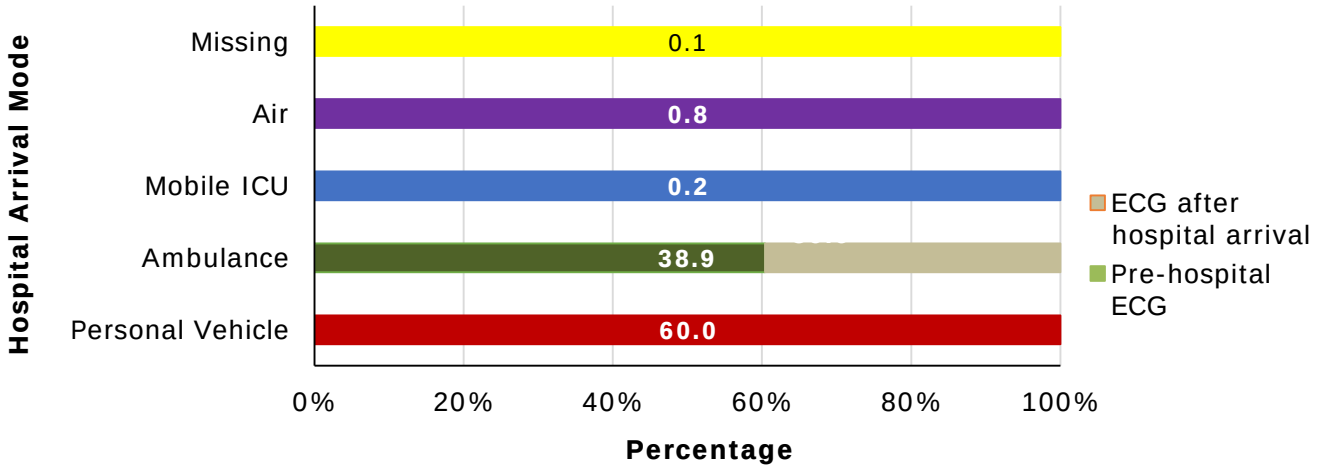

Figure 3. Modes of hospital arrival among all heart attack cases, and among those transported by ambulance, percentage of cases receiving an ECG before vs. after hospital arrival, 2008-2017. Bars sum to 100%.

Of the 37,272 male heart attack cases reported, 62 in 100 (61.8%) were transported to the hospital by personal vehicle. Four in ten male heart attack cases (36.9%) arrived by ambulance, with 63% of these having an ECG performed prior to hospital arrival. Of the 11,238 female heart attack cases reported, 57 in 100 were transported by personal vehicle. Roughly four in ten female heart attack cases (42.5%) arrived by ambulance. While this was similar to the percentage of male cases transported by ambulance, fewer females (56.0%) had an ECG performed prior to hospital arrival. Hospital transport by mobile ICU or air was uncommon for either gender (0.8% female, 1.1% male). Mode of hospital transport was missing for 0.1% of male or female cases.

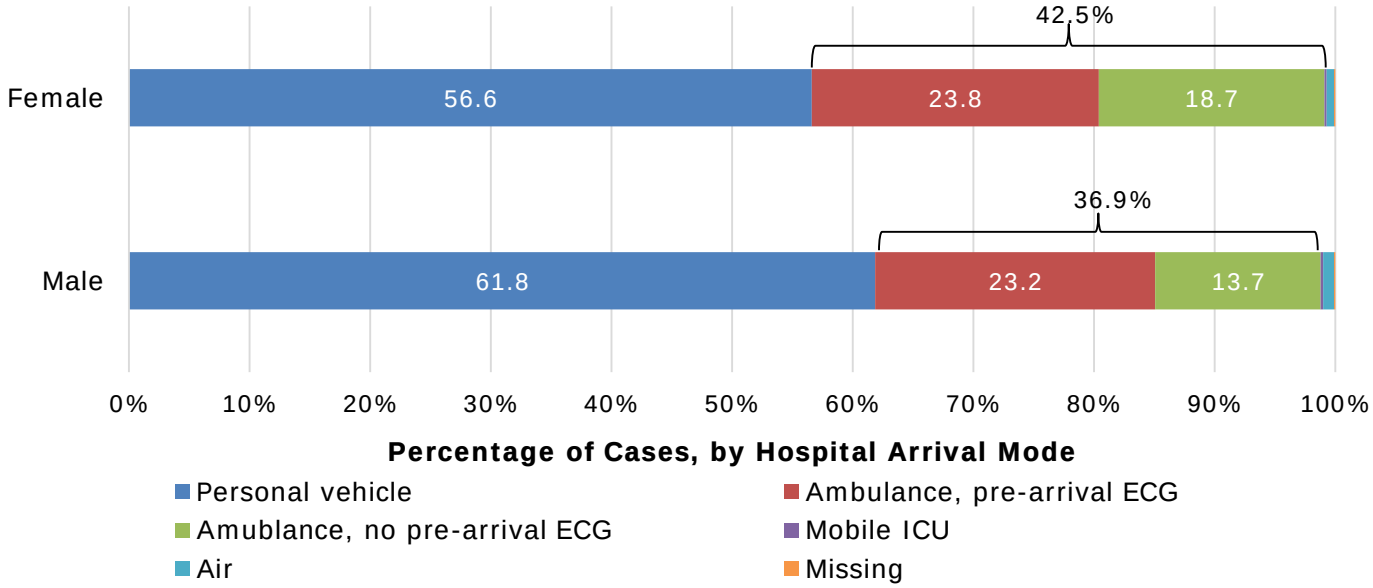

Figure 4. Modes of hospital arrival among heart attack cases, by gender, and among those transported by ambulance, percentage of cases receiving an ECG before vs. after hospital arrival 2008-2017. Percentages for each bar total 100%.

When comparing modes of hospital arrival among heart attack cases by race/ethnicity, over half of all heart attack cases arrived by private vehicle (60.8% White only, 53.9% Black only, and 65.2% Hispanic). Fewer White or Hispanic cases arrived by ambulance as compared with Black cases (38.0%, 34.3%, and 45.4%, respectively). Heart attack cases transported by ambulance who received a pre-hospital arrival ECG were overall similar: 59.6% of White, 61.8% of Black, and 57.4% of Hispanic cases. Mode of hospital transport was missing for 0.1% of White or Hispanic heart attack cases.

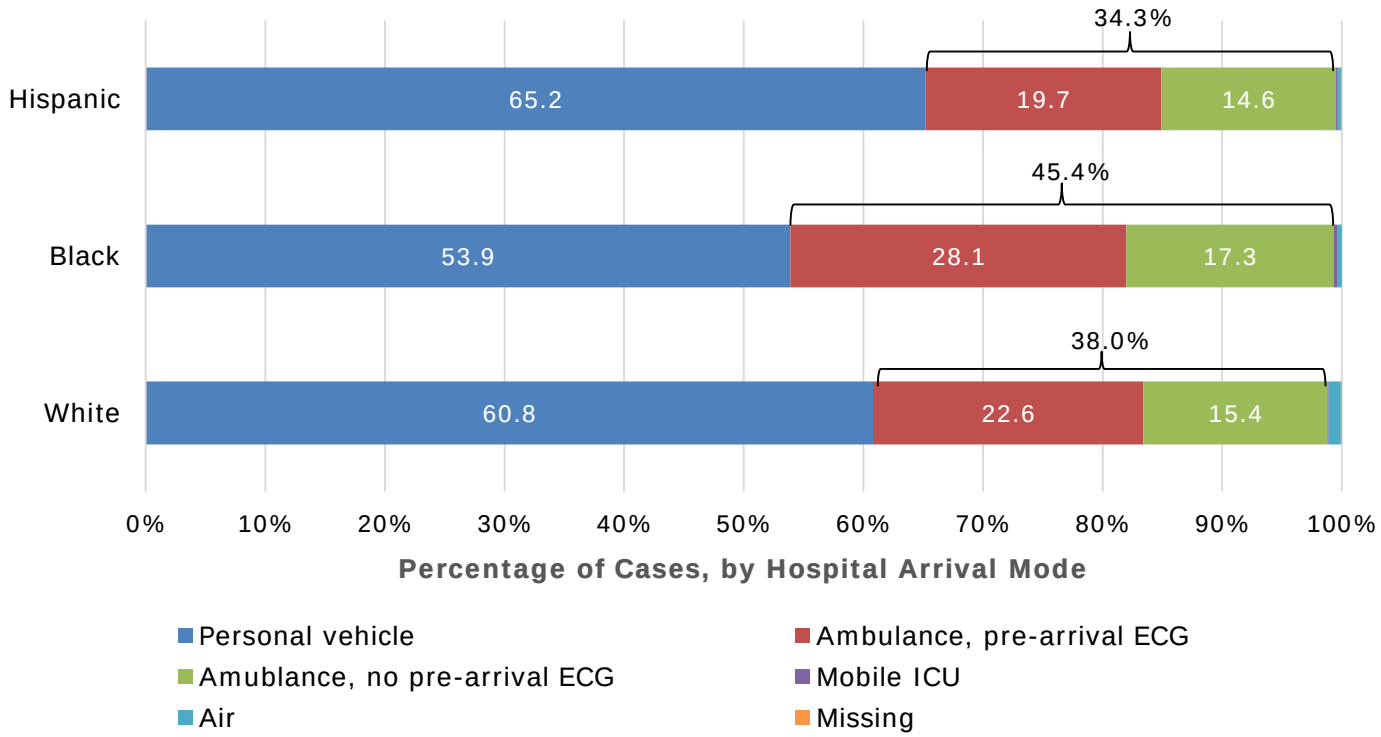

Figure 5. Modes of hospital arrival among heart attack cases, by race/ethnicity, and among those transported by ambulance, percentage of cases receiving an ECG before vs. after hospital arrival, 2008-2017. Percentages for each bar total 100%.

The graphs and tables that follow display either numbers (N) and percentages (%) or median values for specific measures of effective care for heart attack. When presenting data by mode of hospital arrival, data with more than 100 cases reported for each mode of hospital arrival are displayed by year, using seven full years of data, from the first quarter of 2009 through the fourth quarter of 2017 (January 2009-December 2017). For measures with less than 100 cases reported for each mode of hospital arrival, the data are cumulative, using all available data from the fourth quarter of 2008 through the fourth quarter of 2017 (October 2008-December 2017). Data may also be stratified by patient type, that is, whether the patient was transferred in from another hospital (STEMI referral) or presented directly to a PCI-capable hospital (STEMI receiving). The measures include:

1. Pre-hospital ECG within 10 minutes of first medical contact
2. Time from first hospital arrival to first ECG
3. First ECG within 10 minutes of first hospital arrival
4. Dwell time in the emergency department (ED)
    a. Dwell time in the ED of referral hospital
    b. Dwell time in the ED of receiving hospital
5. First door-to-needle time for transfer patients
6. Door-to-needle time within 30 minutes for transfer patients
7. Door-to-balloon time for directly-admitted patients
    a. Median time from hospital arrival to primary PCI (in minutes)

    b. Primary PCI within 90 minutes of hospital arrival
8. First door-to-balloon time for transfer patients
    a. Median time from first hospital arrival to primary PCI (in minutes)
    b. Primary PCI within 120 minutes of arrival to first hospital
    c. Primary PCI within 90 minutes of arrival to first hospital
9. Median time from first medical contact to balloon time
10. Total ischemic time for STEMI transfer patients
11. Total ischemic time for STEMI directly-admitted patients
12. Activation of catheterization lab prior to arrival among transfer patients
13. Activation of catheterization lab prior to arrival among directly-admitted patients
14. Referral to rehabilitation
15. Percentage of comorbidities among all MI patients
16. Smoking cessation advice at discharge
17. Medications administered within first 24 hours
18. Medications prescribed at discharge

Additional information, including data sources, inclusion criteria, and exclusion criteria, can be found in the Appendix.

PRE-HOSPITAL ECG WITHIN 10 MINUTES OF FIRST MEDICAL CONTACT, ALL MI CASES

The ability to diagnose a STEMI early is an initial, and perhaps most important, step that impacts MI survival. An Emergency Medical Services (EMS) unit equipped with 12-lead equipment (i.e., 12-lead ECG capability) can identify a STEMI patient and communicate with the receiving hospital, leading to activation of the catheterization lab and a more efficient system of care. In an optimal system of care, a pre-hospital ECG will allow an MI patient to bypass the emergency department (ED) and advance directly to treatment in the catheterization lab. The sooner EMS staff can perform an ECG and accurately interpret the findings, the timelier the communication of results to the receiving hospital, and the more time the receiving hospital has to prepare for the incoming patient.

Figure 6 and Table 8, below, display the percentage of eligible episodes of care for heart attack in which patients received their first ECG within 10 minutes of first medical contact. The cases included in this measure arrived at the hospital by an ambulance equipped to perform pre-hospital ECGs.

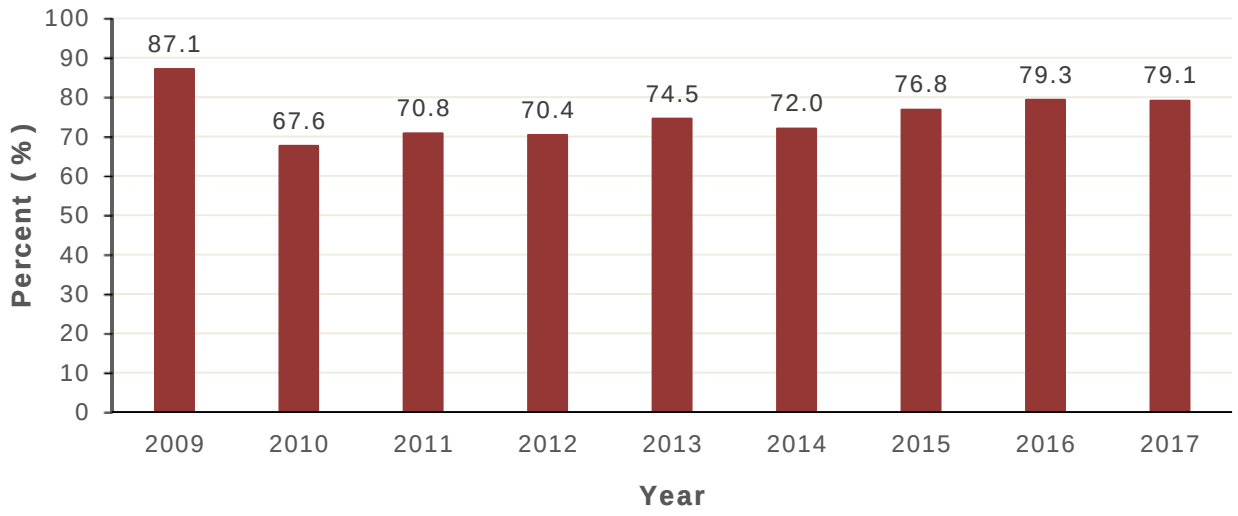

Figure 6. Pre-Hospital ECG within 10 minutes of first medical contact among all heart attack cases arriving by ambulance, by year, 2009-2017.

Table 8. Pre-hospital ECG within 10 minutes of first medical contact among all heart attack cases arriving by ambulance, by year, 2009-2017.

Year	Cases with pre-hospital ECG (n)	Cases with pre-hospital ECG within 10 minutes of first medical contact (n)	%	Reporting hospitals (n)
2009	93	81	87.1	6
2010	376	254	67.6	18
2011	764	541	70.8	26
2012	1,130	796	70.4	33
2013	1,344	1,001	74.5	36
2014	1,656	1,193	72.0	41
2015	1,895	1,455	76.8	45
2016	2,440	1,934	79.3	47
2017	2,253	1,781	79.1	48

In 2017, 4 out of 5 MI cases who received a pre-hospital ECG had their ECG done within 10 minutes of first medical contact. The percentage of cases receiving their ECG within 10 minutes of first medical contact was slightly lower for those in rural vs. urban settings (74.5% vs. 79.6%, respectively).

There is an opportunity to increase the percentage of patients with pre-hospital ECG. In order to improve EMS performance in this measure, it is important to first consider ECG capability among the responding EMS units. Possessing the equipment to perform an ECG, and transmit the results, greatly affects the timeliness of care for MI patients. For ambulances having 12-lead equipment, implementation of a standard EMS protocol for care of suspected MI patients should include performance of an ECG within 10 minutes of first medical contact.

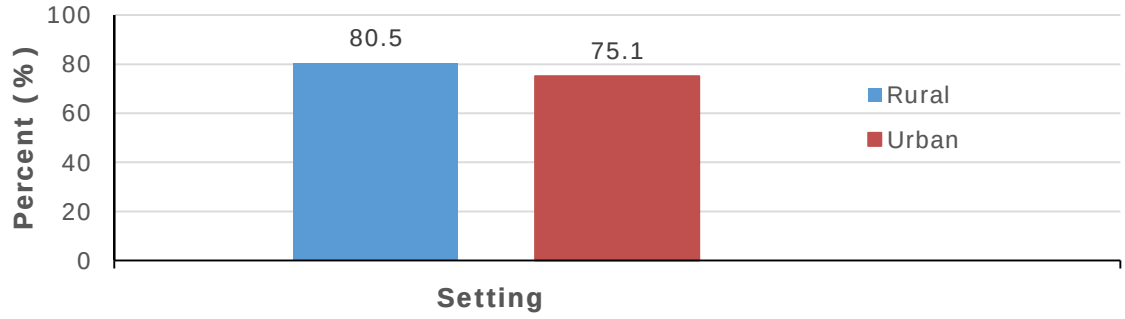

Figure 7. Pre-Hospital ECG within 10 minutes of first medical contact among all heart attack cases who arrived by ambulance and had a pre-hospital ECG performed, by urban /rural setting, 2008–2017.

TIME FROM HOSPITAL ARRIVAL TO FIRST ECG AMONG STEMI TRANSFER CASES

Performing an ECG is the first step in heart attack care within the hospital, and not having one performed in a timely manner can have a detrimental effect on the patient's outcome. The national standard for hospital ECG performance time is within 10 minutes of hospital arrival. [4] Rapid ECG performance and interpretation can lead to reduced dwell time in the ED for a heart attack patient, and to timely activation of the catheterization lab.

Figure 8 and Table 9, below, display the median time (in minutes) elapsed from hospital arrival to performance of first ECG among transfer cases with eligible episodes of care for heart attack, by mode of arrival to the first hospital, by year. Episodes of care in which a patient received an ECG prior to arriving at the hospital were excluded.

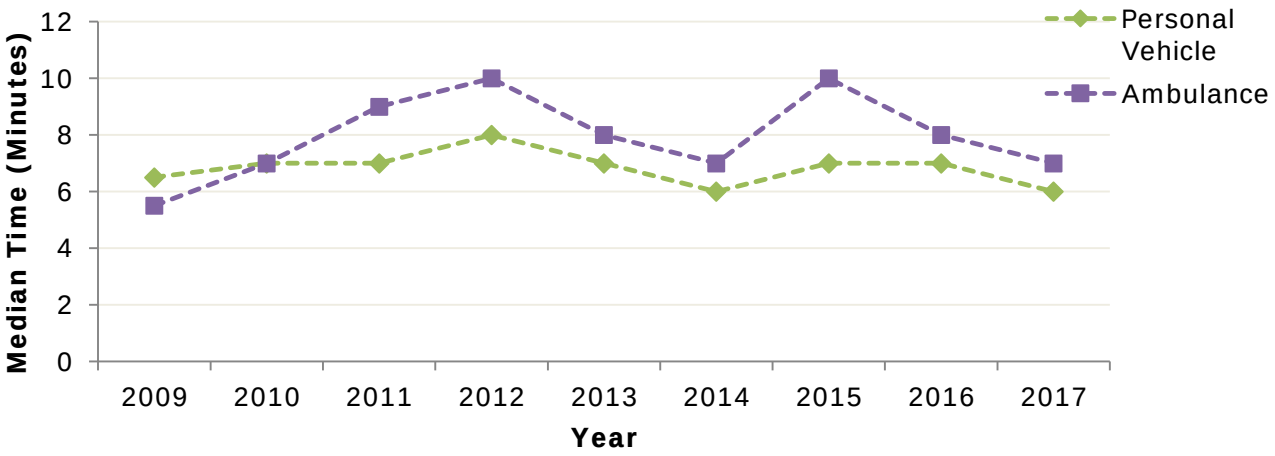

Figure 8. Median time (minutes) from first hospital arrival to first ECG among transfer cases, by mode of arrival to first hospital, by year, 2009-2017.

Table 9. Median time (minutes) from first hospital arrival to first ECG among transfer cases, by mode of arrival to first hospital, by year, 2009-2017.

	Mode of arrival to STEMI referral hospital				
	Personal vehicle		Ambulance		Reporting hospitals (n)
Year	Cases with ECG (n)	Minutes (Median)	Cases with ECG (n)	Minutes (Median)	
2009	270	6.5	78	5.5	6
2010	570	7.0	191	7.0	17
2011	794	7.0	218	9.0	22
2012	940	8.0	210	10.0	30
2013	1,138	7.0	228	8.0	34
2014	1,144	6.0	200	7.0	40
2015	1,431	7.0	207	10.0	42
2016	1,458	7.0	190	8.0	44
2017	1,345	6.0	157	7.0	47

The median time to first ECG for transferred STEMI cases who arrived by personal vehicle to the hospital ranged from a low of 6 minutes in 2014 and 2017 to a high of 8 minutes in 2012. The median time for those who arrived by ambulance ranged from a low of 5.5 minutes in 2009 to a high of 10 minutes in 2012 and 2015. Each year since 2011, the median time from first hospital arrival to first ECG was roughly 1-3 minutes longer for those arriving by ambulance than by personal vehicle.

TIME FROM HOSPITAL ARRIVAL TO FIRST ECG AMONG DIRECTLY-ADMITTED STEMI CASES

Figure 9 and Table 10, below, display the median time (in minutes) elapsed from hospital arrival to performance of first ECG among directly-admitted STEMI cases with eligible episodes of care for heart attack, by mode of arrival to the hospital, by year. Episodes of care in which a patient received an ECG prior to arriving at the hospital were excluded.

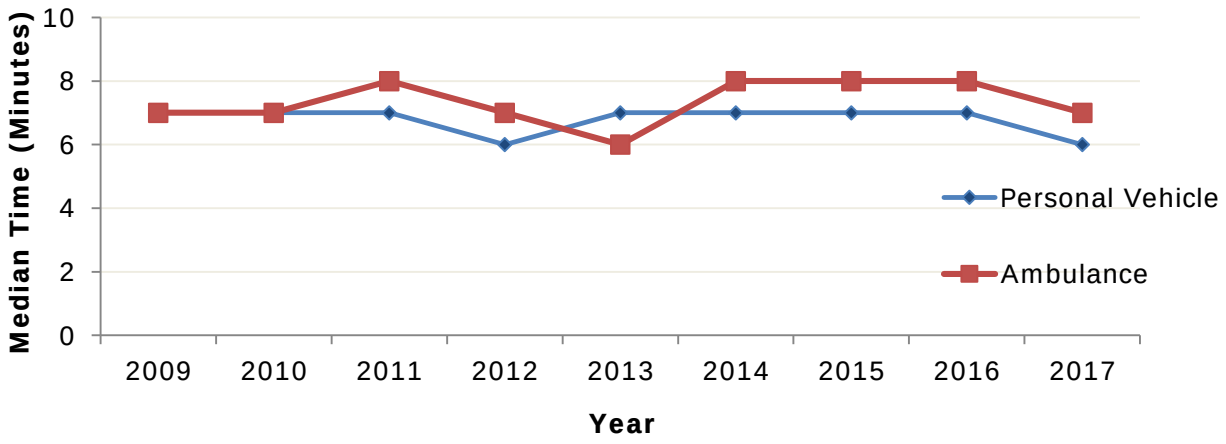

Figure 9. Median time from first hospital arrival to first ECG among directly-admitted STEMI cases, by mode of arrival to hospital, by year, 2009-2017.

Table 10. Median time from hospital arrival to first ECG among directly-admitted STEMI cases, by mode of arrival to hospital, by year, 2009-2017.

	Mode of arrival to STEMI receiving hospital				
	Personal vehicle		Ambulance		Reporting hospitals (n)
Year	Cases with ECG (n)	Minutes (Median)	Cases with ECG (n)	Minutes (Median)	
2009	205	7	86	7	12
2010	1,213	7	568	7	23
2011	2,151	7	852	8	28
2012	2,730	6	926	7	34
2013	2,838	7	1,098	6	38
2014	3,447	7	1,050	8	42
2015	3,617	7	880	8	45
2016	4,143	7	712	8	48
2017	4,029	6	683	7	48

The median time to first ECG for directly-admitted STEMI cases who arrived by personal vehicle to the hospital ranged from a low of six minutes in 2012 and 2017 to a high of seven minutes all other reporting years. The median time for those who arrived by ambulance ranged from a low of six minutes in 2013 to a high of eight minutes in 2011 and 2014-2016.

HOSPITAL ECG WITHIN 10 MINUTES OF ARRIVAL AMONG STEMI TRANSFER CASES

Figure 10 and Table 11, below, display the percentage of eligible episodes of care for heart attack in which transfer patients received an ECG within 10 minutes of arriving at the first hospital to which they presented, by mode of arrival to the first hospital, by year. Episodes of care in which a patient received an ECG prior to arriving at the hospital were excluded.

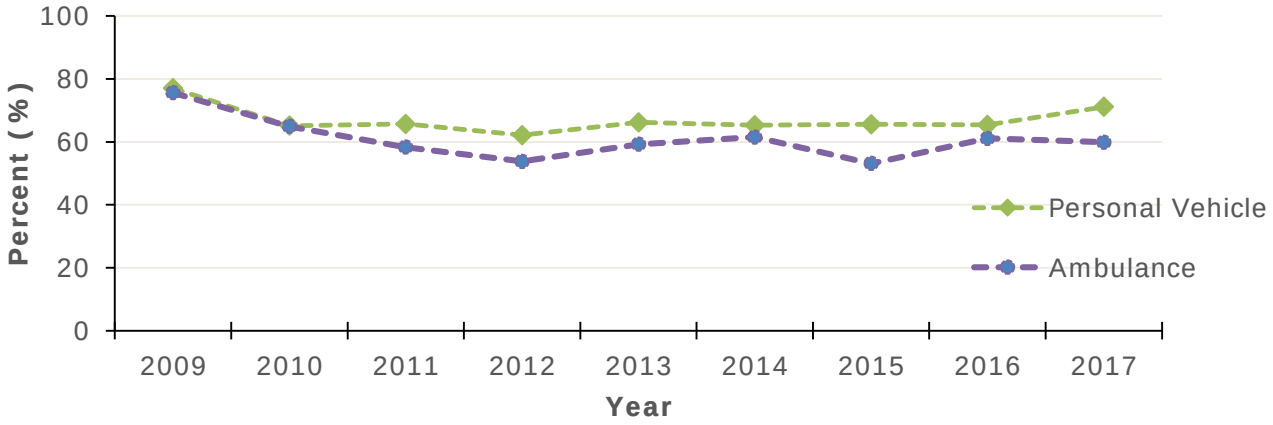

Figure 10. Hospital ECG within 10 minutes of first hospital arrival among transfer cases, by mode of arrival to first hospital, by year, 2009-2017.

Table 11. Hospital ECG within 10 minutes of first hospital arrival among transfer cases, by mode of arrival to first hospital, by year, 2009-2017.

	Mode of arrival to STEMI referral hospital						
	Personal vehicle			Ambulance			
Year	Cases with ECG (n)	Cases with ECG within 10 minutes of hospital arrival (n)	%	Cases with ECG (n)	Cases with ECG within 10 minutes of hospital arrival (n)	%	Reporting hospitals (n)
2009	270	208	77.0	78	59	75.6	6
2010	570	371	65.1	191	124	64.9	17
2011	794	522	65.7	218	127	58.3	22
2012	940	584	62.1	210	113	53.8	30
2013	1,138	753	66.2	228	135	59.2	34
2014	1,144	747	65.3	200	123	61.5	40
2015	1,431	939	65.6	207	110	53.1	42
2016	1,458	954	65.4	190	116	61.1	44
2017	1,345	956	71.1	157	94	59.9	47

In 2017, of all MI cases with an ECG performed at a STEMI referral hospital, a greater percentage of those arriving by personal vehicle had their ECG performed within 10 minutes of arriving at the hospital as compared with those arriving by ambulance. This general trend is seen for the past seven years. There is opportunity for improvement in this vital component of care. Implementing appropriate protocols within the hospital ED can lead to more efficient care and improved times for first in-hospital ECG.

HOSPITAL ECG WITHIN 10 MINUTES OF ARRIVAL AMONG DIRECTLY-ADMITTED STEMI CASES

Figure 11 and Table 12, below, display the percentage of eligible episodes of care for heart attack in which directly-admitted patients received an ECG within 10 minutes of arriving at the hospital, by mode of arrival to the hospital, by year. Episodes of care in which a patient received an ECG prior to arriving at the hospital were excluded.

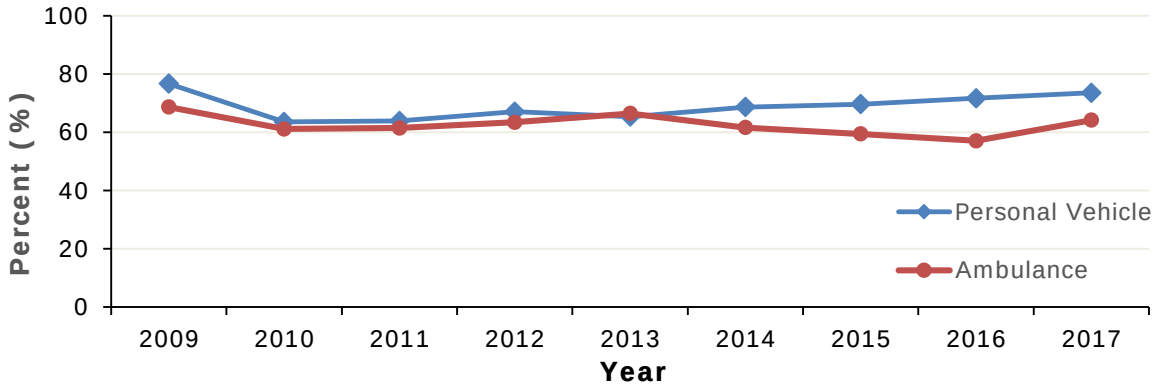

Figure 11. Hospital ECG within 10 minutes of arrival among directly-admitted cases, by mode of arrival to hospital, by year, 2009-2017.

Table 12. Hospital ECG within 10 minutes of arrival among directly-admitted cases, by mode of arrival to hospital, by year, 2009-2017.

	Mode of arrival to STEMI receiving hospital						
	Personal vehicle			Ambulance			
Year	Cases with ECG (n)	Cases with ECG within 10 minutes of hospital arrival (n)	%	Cases with ECG (n)	Cases with ECG within 10 minutes of hospital arrival (n)	%	Reporting hospitals (n)
2009	205	157	76.6	86	59	68.6	12
2010	1,213	770	63.5	568	347	61.1	23
2011	2,151	1,372	63.8	852	523	61.4	28
2012	2,730	1,828	67.0	926	587	63.4	34
2013	2,838	1,852	65.3	1,098	729	66.4	38
2014	3,447	2,366	68.6	1,050	647	61.6	42
2015	3,617	2,517	69.6	880	523	59.4	45
2016	4,143	2,968	71.6	712	406	57.0	48
2017	4,029	2,960	73.5	683	438	64.1	48

In 2017, of all MI cases with an ECG performed among directly-admitted cases at a STEMI receiving hospital, a greater percentage of those arriving by personal vehicle had their ECG performed within 10 minutes of arriving at the hospital as compared with those arriving by ambulance. While there was not much difference in these percentages from 2010-2013, the percentages have diverged more noticeably as of 2014. Hospital ECG within 10 minutes of arrival is recommended both in transfer and directly-admitted patients, irrespective of their mode of arrival. Even though this report shows that a higher number of patients arriving by a personal vehicle had a hospital ECG within 10 minutes of arrival, it is always recommended that MI patients arrive by ambulance. This is primarily to allow for recognition of STEMI when ECG is performed in the ambulance, leading to timely activation of cardiac catheterization lab. This can decrease the patients' total ischemic time and improve clinical outcomes.

DWELL TIME IN THE EMERGENCY DEPARTMENT OF STEMI REFERRAL HOSPITALS

The standard of care for time from arrival at first hospital to PCI, including transfer time, is 120 minutes. [3] The transfer process adds another component that must be evaluated as part of the STEMI system of care. The time spent in the referral facility is critical in this transfer process. It is an element that can be improved upon through streamlined processes and protocols, whereas transport time is more difficult to address due to other factors, such as distance to the nearest STEMI receiving hospital.

Figure 12 and Table 13, below, display the median time (in minutes) STEMI cases spent awaiting transfer (from the STEMI referral hospital to the STEMI receiving hospital) for PCI, among eligible episodes of care, by mode of arrival to the referral hospital.

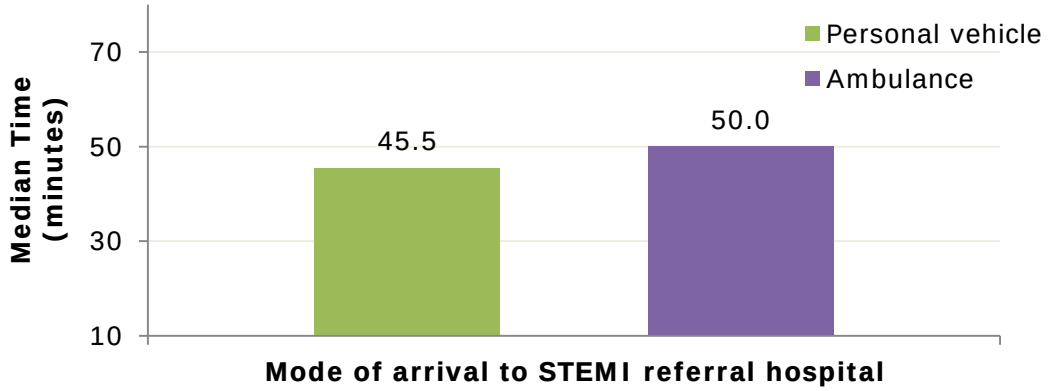

Figure 12. Median time spent in the emergency department (ED) of the STEMI referral hospital among transfer cases, by mode of arrival to first hospital, 2008-2017.

Table 13. Median time spent in the emergency department (ED) of the STEMI referral hospital among transfer cases, by mode of arrival to first hospital, 2008-2017.

	Mode of arrival to STEMI referral hospital				
	Personal vehicle		Ambulance		
Patient Type	STEMI cases (n)	Minutes (Median)	STEMI cases (n)	Minutes (Median)	Reporting hospitals (n)
Transfer from referral hospital	102	45.5	32	50.0	10

The median time spent awaiting transfer from the STEMI referral hospital to the STEMI receiving hospital for PCI was 45.5 minutes among those who arrived by personal vehicle and 50 minutes among those who arrived by ambulance. For referral hospitals, there should be protocols in place for identifying, transferring, and transporting a STEMI patient to a receiving hospital. Implementing such a protocol requires rapid performance and interpretation of ECG as well as communication to the receiving hospital for activation of its catheterization lab.

DWELL TIME IN THE EMERGENCY DEPARTMENT OF RECEIVING HOSPITAL AMONG STEMI TRANSFER CASES

Figure 13 and Table 14, below, display the median time (in minutes) STEMI cases spent waiting in the ED of the STEMI receiving hospital among transfer cases with eligible episodes of care for STEMI, by mode of arrival to first hospital, by year.

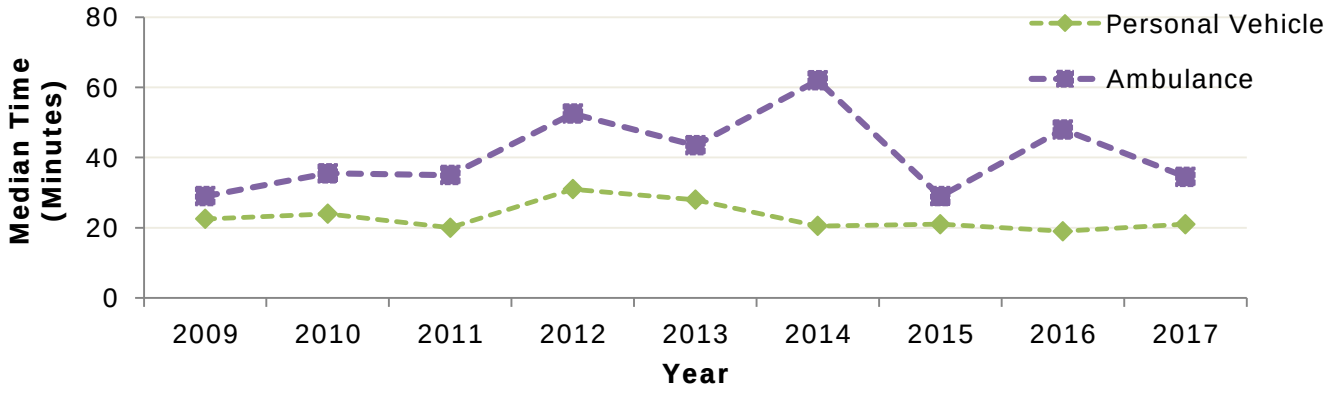

Figure 13. Median time spent in the Emergency Department of the STEMI receiving hospital among transfer cases, by mode of arrival to first hospital, by year, 2009-2017.

Table 14. Median time spent in the Emergency Department of the STEMI receiving hospital among transfer cases, by mode of arrival to first hospital, by year, 2009-2017.

	Mode of arrival to STEMI receiving hospital				
	Personal vehicle		Ambulance		
Year	STEMI cases (n)	Minutes (Median)	STEMI cases (n)	Minutes (Median)	Reporting hospitals (n)
2009	20	22.5	5	29.0	2
2010	43	24.0	34	35.5	10
2011	81	20.0	20	35.0	13
2012	82	31.0	26	52.5	16
2013	87	28.0	14	43.5	17
2014	84	20.5	23	62.0	22
2015	99	21.0	19	29.0	27
2016	142	19.0	25	48.0	28
2017	118	21.0	22	34.5	24

STEMI transfer cases arriving via private vehicle spend less time in the STEMI receiving hospital's ED as compared with those arriving via ambulance. In 2017, the median dwell time as 13.5 minute longer for those arriving by ambulance than by personal vehicle. There is opportunity for establishing protocols and improving communication between STEMI receiving and STEMI referral hospitals that could reduce patients' dwell time in the ED of the STEMI receiving hospital.

DWELL TIME IN THE EMERGENCY DEPARTMENT OF RECEIVING HOSPITAL AMONG STEMI DIRECTLY-ADMITTED CASES

Figure 14 and Table 15**,** below, display the median time (in minutes) spent waiting in the ED of STEMI receiving hospital among directly-admitted STEMI cases with eligible episodes of care for STEMI, by mode of arrival to hospital, by year.

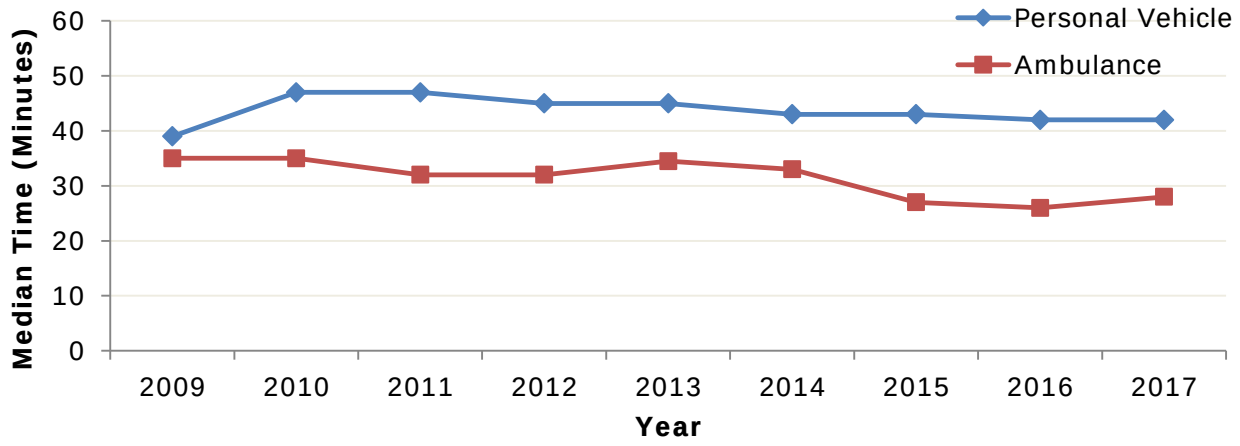

Figure 14. Median time spent in the Emergency Department of STEMI receiving hospitals among directly-admitted STEMI cases, by mode of arrival to hospital, 2009-2017.

Table 15. Median time spent in the Emergency Department of STEMI receiving hospitals among directly-admitted STEMI cases, by mode of arrival to hospital, 2009-2017.

	Mode of arrival to STEMI receiving hospital				
	Personal vehicle		Ambulance		
Year	STEMI Cases (n)	Minutes (Median)	STEMI Cases (n)	Minutes (Median)	Reporting hospitals (n)
2009	61	39	67	35	9
2010	255	47	241	35	21
2011	428	47	464	32	25
2012	528	45	533	32	32
2013	563	45	728	35	33
2014	703	43	742	33	40
2015	756	43	851	27	45
2016	819	42	968	26	48
2017	793	42	949	28	48

Among directly-admitted STEMI cases, those arriving via private vehicle spend more time in the hospital's ED as compared with those arriving via ambulance. In 2017, the median dwell time as 14 minute longer for those arriving by personal vehicle than by ambulance. This further supports that MI cases should consider transport via ambulance over personal vehicle, as this could reduce dwell time in the ED of the STEMI receiving hospital.

FIRST DOOR-TO-NEEDLE TIME AMONG STEMI TRANSFER CASES

Fibrinolysis, or use of a clot-dissolving drug to restore blood flow, can be used by hospitals that are not PCI-capable and cannot transfer a patient to receive PCI within the recommended time. It is also an option for patients who are ineligible for PCI. Fibrinolytic therapy should be administered within 30 minutes of hospital arrival. [4]

Figure 15 and Table 16, below, display the median time (in minutes) elapsed from arrival at first hospital to receipt of fibrinolytic therapy as the primary reperfusion treatment at the same hospital, among eligible episodes of care for STEMI, by mode of arrival to first hospital. The cases included in this measure were later transferred to another hospital. It is important to note the number of eligible cases for this measure was less than 100.

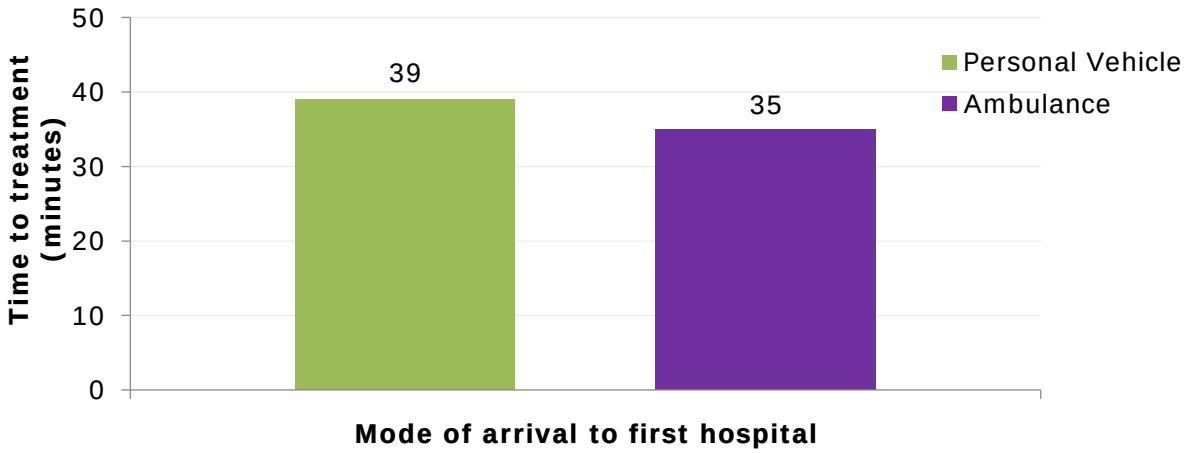

Figure 15. Median time from arrival to primary fibrinolysis at first hospital among STEMI transfer cases, by mode of arrival to first hospital, 2008-2017.

Table 16. Median time from arrival at first hospital to primary fibrinolysis among STEMI transfer cases, by mode of arrival to first hospital, 2008-2017.

	Mode of arrival to first hospital				
	Personal Vehicle		Ambulance		
Patient Type	Cases receiving fibrinolysis at first hospital (N)	Minutes (Median)	Cases receiving fibrinolysis at first hospital (N)	Minutes (Median)	Reporting hospitals (N)
Transfer	73	39	26	35	16

Among STEMI cases who arrived at the first hospital by personal vehicle, the median time from hospital arrival to fibrinolytic therapy was 39 minutes, compared to a median time of 35 minutes for those arriving to the first hospital by ambulance. This lends additional support for urging MI cases to consider transport via ambulance over personal vehicle, as this could improve the time from hospital arrival to treatment with fibrinolysis.

DOOR-TO-NEEDLE TIME WITHIN 30 MINUTES AMONG STEMI TRANSFER CASES

Figure 16 and Table 17, below, display the percentage of eligible STEMI cases receiving primary fibrinolysis as the primary reperfusion strategy within 30 minutes of arrival at first hospital, by mode of arrival to first hospital. The patients included in this measure were later transferred to another hospital. It is important to note the number of eligible cases for this measure was less than 100.

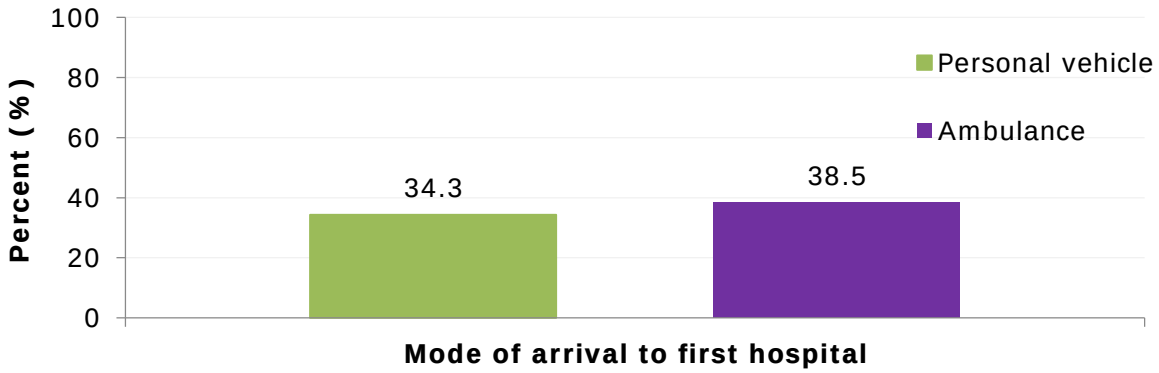

Figure 16. Fibrinolysis within 30 minutes of first hospital arrival among transfer cases, by mode of arrival to first hospital, 2008-2017.

Table 17. Fibrinolysis within 30 minutes of first hospital arrival among transfer cases, by mode of arrival to first hospital, 2008-2017.

	Mode of arrival to STEMI referral hospital						
	Personal vehicle			Ambulance			
Patient Type	Cases receiving fibrinolysis at STEMI referral hospital	Cases receiving fibrinolysis within 30 minutes of arrival at STEMI referral hospital		Cases receiving fibrinolysis at STEMI referral hospital	Cases receiving fibrinolysis within 30 minutes of arrival at STEMI referral hospital		Reporting hospitals
	N	n	%	N	n	%	N
Transfer	73	25	34.3	26	10	38.5	16

The recommended door-to-needle time in STEMI referral hospitals is no more than 30 minutes. [5] In Texas, between 2008 and 2017, only one-third (34.3%) of STEMI cases arriving to the referral hospital by personal vehicle or by ambulance (38.5%) were treated to this standard of care. More rapid performance of ECG and protocols to reduce dwell times in the ED of the referral hospitals can improve this measure.

DOOR-TO-BALLOON TIME FOR STEMI DIRECTLY-ADMITTED CASES

The standard of care for time from hospital arrival to PCI (or "device activation") is commonly referred to as "door-to-balloon time", and should be no more than 90 minutes. [5] Figure 17 and Table 18, below, display the median time (in minutes) elapsed from directly-admitted cases arriving at a STEMI receiving hospital to primary PCI among eligible episodes of care for STEMI, by mode of arrival, by year. This measure is significant because it encompasses

all the previous steps that are required for care of STEMI patients, from their arrival at the hospital, their time in the ED, their arrival in the catheterization lab, and device activation.

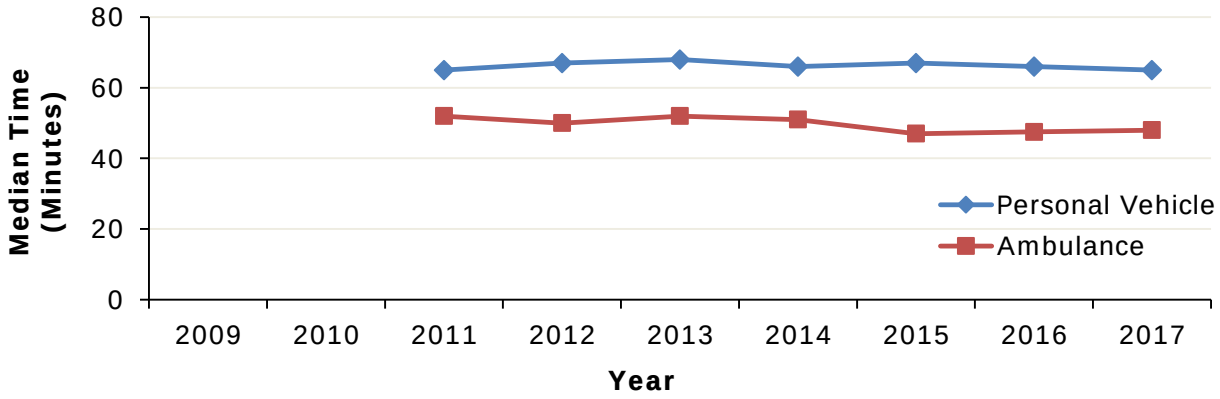

Figure 17. Median time (minutes) from hospital arrival to primary PCI among directly-admitted STEMI cases, by mode of arrival, by year, 2009-2017.

Table 18. Median time (minutes) from hospital arrival to primary PCI among directly-admitted STEMI cases, by mode of arrival, by year, 2009-2017.

	Mode of arrival to STEMI receiving hospital				
	Personal vehicle		Ambulance		
Year	Cases receiving primary PCI at hospital (n)	Minutes (Median)	Cases receiving primary PCI at hospital (n)	Minutes (Median)	Reporting hospitals (n)
2009	--	--	--	--	--
2010	--	--	--	--	--
2011	273	65	299	52	27
2012	393	67	424	50	32
2013	435	68	579	52	34
2014	525	66	590	51	40
2015	538	67	626	47	44
2016	602	66	738	48	47
2017	601	65	717	48	48

-- No data available

Each year, directly-admitted cases arriving by ambulance had a lower median time to PCI than did those who arrived by personal vehicle. In order to further improve the median time to PCI, hospitals can evaluate their protocol for activation of the catheterization lab and aim to have catheterization lab staff arrive within 30 minutes of the activation call.

DOOR-TO-BALLOON TIME WITHIN 90 MINUTES FOR DIRECTLY-ADMITTED STEMI CASES

Figure 18 and Table 19, below, display the percentage of eligible episodes of care for STEMI patients who received primary PCI within 90 minutes of direct presentation to a STEMI receiving hospital, by mode of arrival, by year. Data on this measure are not available prior to 2011.

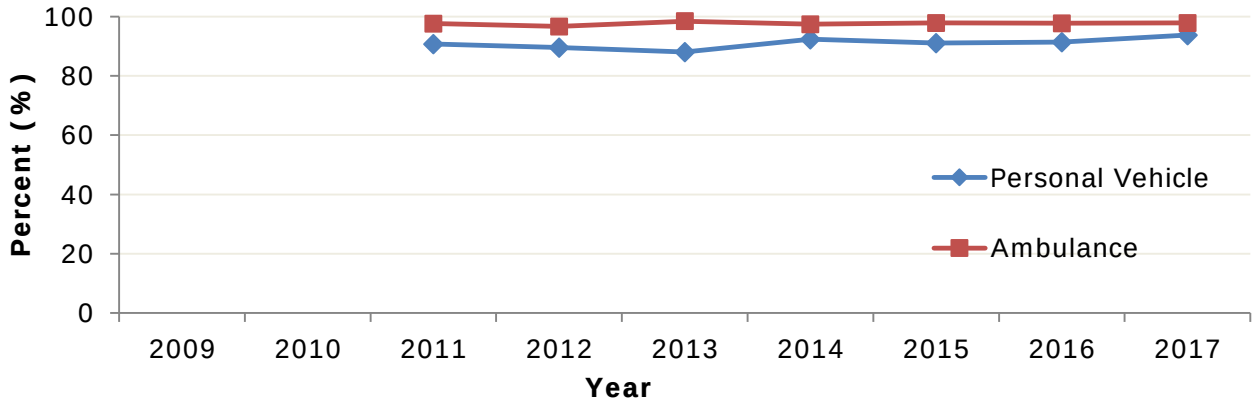

Figure 18. Primary PCI within 90 minutes of hospital arrival among directly-admitted STEMI cases, by mode of arrival, by year, 2009-2017.

Table 19. Primary PCI within 90 minutes of hospital arrival among directly-admitted STEMI cases, by mode of arrival, by year, 2009-2017.

	Mode of arrival to STEMI receiving hospital						
	Personal vehicle			Ambulance			
Year	Cases receiving primary PCI at STEMI receiving hospital (n)	Cases receiving primary PCI within 90 minutes of first hospital arrival (n)	%	Cases receiving primary PCI at STEMI receiving hospital (n)	Cases receiving primary PCI within 90 minutes of first hospital arrival (n)	%	Reporting Hospitals (n)
2009	--	--	--	--	--	--	--
2010	--	--	--	--	--	--	--
2011	273	248	90.8	299	292	97.7	27
2012	393	352	89.6	424	410	96.7	33
2013	435	383	88.1	579	570	98.5	35
2014	525	485	92.4	590	575	97.5	40
2015	538	490	91.1	626	613	97.9	44
2016	602	550	91.4	738	722	97.8	47
2017	601	564	93.8	717	702	97.9	48

Over all reporting years, a higher percentage of directly-admitted STEMI cases who arrived by ambulance received primary PCI within 90 minutes of hospital arrival than did those who arrived by personal vehicle. In 2017, this difference was 4.1%.

FIRST DOOR-TO-BALLOON TIME FOR STEMI TRANSFER CASES

STEMI patients who arrive at a STEMI referral hospital who are eligible for and in need of PCI must be transferred to a STEMI receiving hospital to receive appropriate care and treatment. The standard of care for time from arrival at first hospital to PCI, including transfer time, is 120 minutes. [3] Figure 19 and Table 20, below, display the median time (in minutes) elapsed from arrival at a STEMI referral hospital to time of primary PCI at a STEMI receiving hospital among eligible episodes of care for STEMI, by mode of arrival to the STEMI referral hospital.

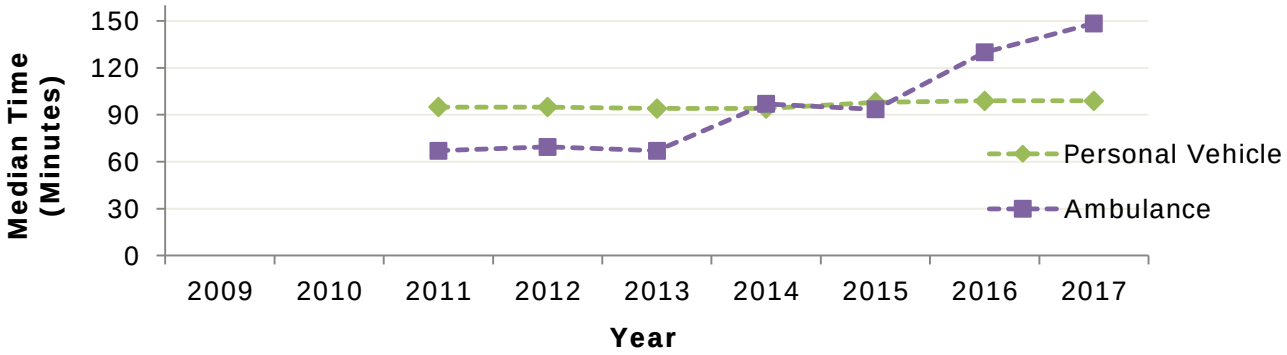

Figure 19. Median time (minutes) from first hospital arrival to primary PCI for STEMI transfer cases, by mode of arrival to first hospital, by year, 2009-2017.

Table 20. Median time from first hospital arrival to primary PCI for STEMI transfer cases, by mode of arrival to first hospital, by year, 2009-2017.

	Mode of arrival to STEMI referral hospital				
	Personal vehicle		Ambulance		
Year	Cases receiving primary PCI at STEMI receiving hospital (n)	Minutes (Median)	Cases receiving primary PCI at STEMI receiving hospital (n)	Minutes (Median)	Reporting hospitals (n)
2009	--	--	--	--	--
2010	--	--	--	--	--
2011	145	95	76	67	17
2012	184	95	86	70	21
2013	201	94	71	67	24
2014	207	94	33	97	29
2015	261	98	42	94	31
2016	241	99	23	130	33
2017	239	99	16	149	31

-- No data available

In 2017, transfer cases arriving at a STEMI referral hospital by ambulance had a longer median time to primary PCI than those who arriving by personal vehicle; this trend has been seen since 2014, whereas prior to 2014, those arriving by ambulance had a shorter median time from arrival to PCI. Identifying and addressing the causes of this difference may lead to improved time to primary PCI and potentially better health outcomes.

FIRST DOOR-TO-BALLOON TIME WITHIN 120 MINUTES FOR STEMI TRANSFER CASES

Figure 20 and Table 21, below, display the percentage of eligible episodes of care for STEMI patients who received primary PCI at a STEMI receiving hospital within 120 minutes of arriving at a STEMI referral hospital, by mode of arrival to the referral hospital, by year.

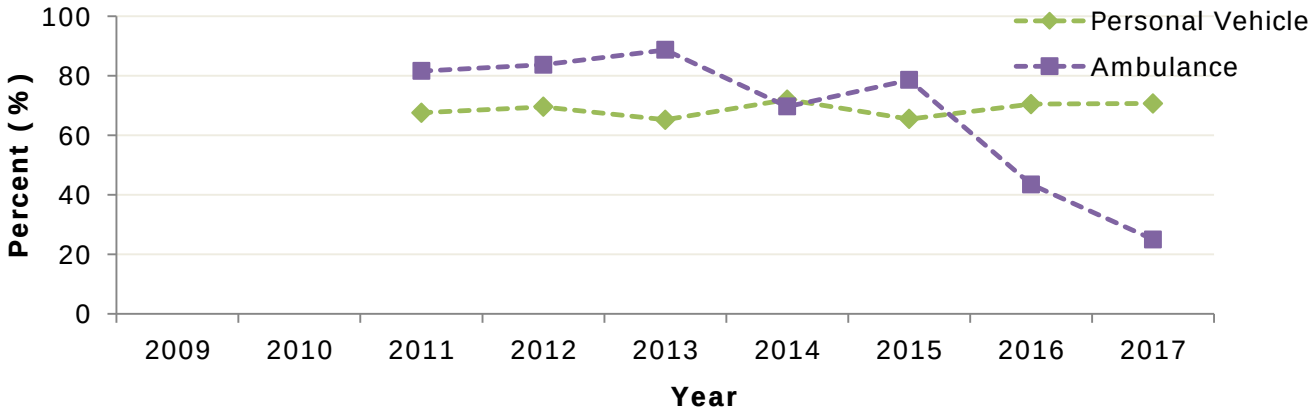

Figure 20. Primary PCI within 120 minutes of first hospital arrival among STEMI transfer cases, by mode of arrival to first hospital, by year, 2009-2017.

Table 21. Primary PCI within 120 minutes of first hospital arrival among STEMI transfer cases, by mode of arrival to first hospital, by year, 2009-2017.

	Mode of arrival to STEMI referral hospital						
	Personal vehicle			Ambulance			
Year	Cases receiving primary PCI at STEMI receiving hospital (n)	Cases receiving primary PCI within 120 minutes of first hospital arrival (n)	%	Cases receiving primary PCI at STEMI receiving hospital (n)	Cases receiving primary PCI within 120 minutes of first hospital arrival (n)	%	Reporting Hospitals (n)
2009	--	--	--	--	--	--	--
2010	--	--	--	--	--	--	--
2011	145	98	67.6	76	62	81.6	17
2012	184	128	69.6	86	72	83.7	21
2013	201	131	65.2	71	63	88.7	24
2014	207	149	72.0	33	23	69.7	29
2015	261	171	65.5	42	33	78.6	31
2016	241	170	70.5	23	10	43.5	33
2017	239	169	70.7	16	4	25.0	31

-- No data available

In 2017, 71 out of 100 (70.7%) STEMI transfer cases who arrived at a STEMI referral hospital by private vehicle received primary PCI within 120 minutes of arrival at the STEMI referral hospital, compared to only 25 out of 100 (25.0%) who arrived at the referral hospital by ambulance.

FIRST DOOR-TO-BALLOON TIME WITHIN 90 MINUTES FOR STEMI TRANSFER CASES

According to American Heart Association's (AHA) STEMI systems of care recommendations, the door to balloon time for transfer patients, including transport time, should be within 90 minutes. [5] Figure 21 and Table 22**,** below, display the percentage of eligible episodes of care for STEMI patients who received primary PCI at a STEMI receiving hospital within 90 minutes of arriving at a STEMI referral hospital, by mode of arrival to STEMI referral hospital, by year.

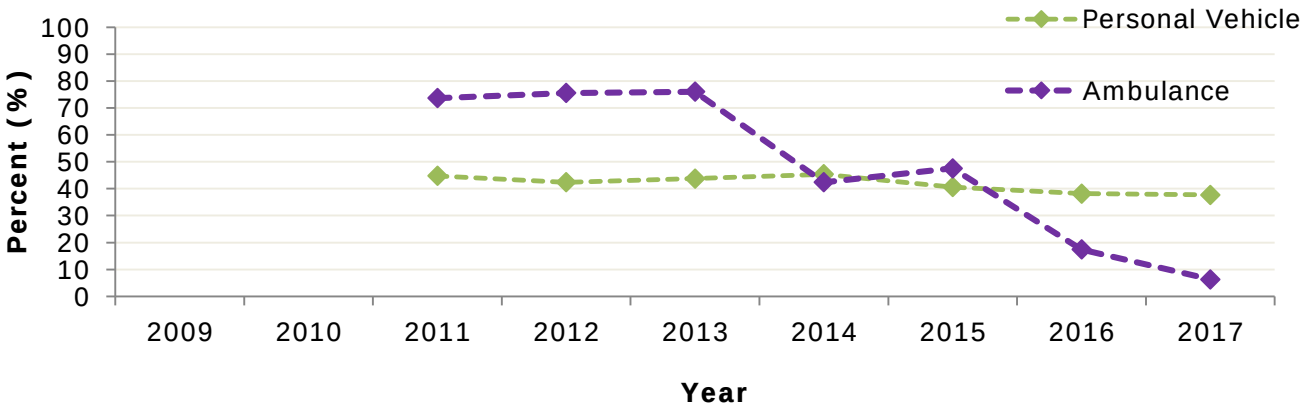

Figure 21. Primary PCI within 90 minutes of first hospital arrival among STEMI transfer cases, by mode of arrival to first hospital, by year, 2009-2017.

Table 22. Primary PCI within 90 minutes of first hospital arrival among STEMI transfer cases, by mode of arrival to first hospital, by year, 2009-2017.

	Mode of arrival to STEMI referral hospital						
	Personal vehicle			Ambulance			
Year	Cases receiving primary PCI at STEMI receiving hospital (n)	Cases receiving primary PCI within 90 minutes of first hospital arrival (n)	%	Cases receiving primary PCI at STEMI receiving hospital (n)	Cases receiving primary PCI within 90 minutes of first hospital arrival (n)	%	Reporting Hospitals (n)
2009	--	--	--	--	--	--	--
2010	--	--	--	--	--	--	--
2011	145	65	44.8	76	56	73.7	17
2012	184	78	42.4	86	65	75.6	21
2013	201	88	43.8	71	54	76.1	24
2014	207	94	45.4	33	14	42.4	29
2015	261	106	40.6	42	20	47.6	31
2016	241	92	38.2	23	4	17.4	33
2017	239	90	37.7	16	1	6.3	31

-- No data available

In 2017, almost six time more cases arriving at a STEMI referral hospital by personal vehicle received primary PCI within 90 minutes than did those who arrived by ambulance (37.7% vs. 6.3%, respectively).

The number of cases arriving via ambulance to STEMI referral hospitals has been decreasing since 2013. One reason for this may be that ambulances are bypassing STEMI referral hospitals and transporting cases directly to STEMI receiving hospitals in efforts to decrease ischemic times and improve outcomes.

FIRST MEDICAL CONTACT (FMC) TO BALLOON TIME AMONG STEMI CASES

According to both the 2013 American College of Cardiology Foundation and the AHA STEMI guidelines, in order to improve STEMI outcomes, the focus and emphasis has shifted to targeting first medical contact (FMC) to balloon time rather than door-to-balloon time. [6] Figure 22 and Table 23**,** below, display the median time from FMC to balloon time, by year, for STEMI cases who arrived by an ambulance to the first hospital. Both transfers and directly-admitted cases were included.

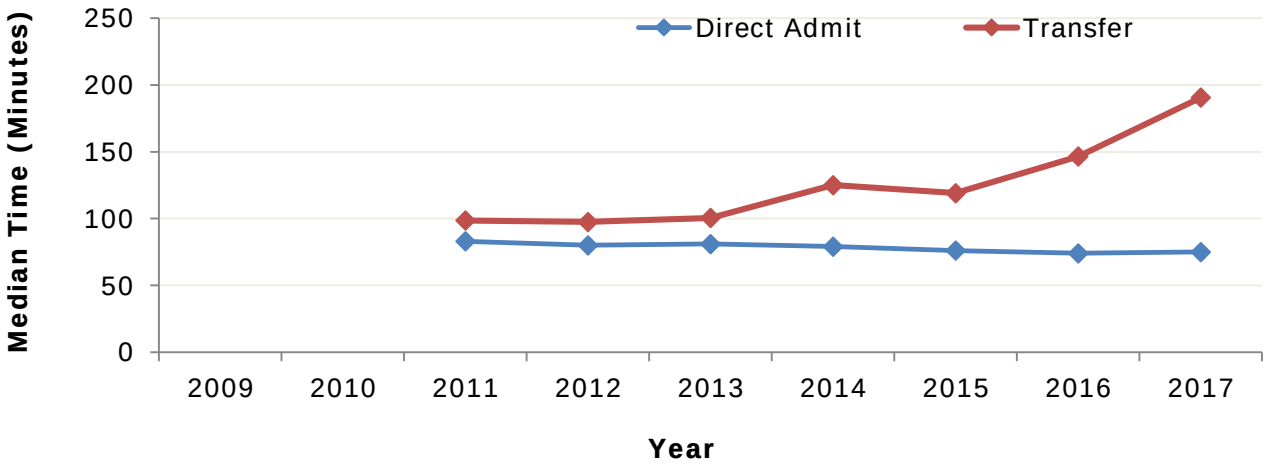

Figure 22. Median time, in minutes, from first medical contact to balloon time among STEMI cases who arrived at the first hospital by ambulance, by admit type, by year, 2009-2017.

Table 23. Median time, in minutes, from first medical contact to balloon time among STEMI cases who arrived at the first hospital by ambulance, by admit type, by year, 2009-2017.

	Admit Type					
	Directly-admitted			Transfer		
Year	Cases receiving primary PCI at STEMI receiving hospital (n)	Minutes (Median)	Reporting Hospitals (n)	Cases receiving primary PCI at STEMI receiving hospital (n)	Minutes (Median)	Reporting Hospitals (n)
2009	--	--	--	--	--	--
2010	--	--	--	--	--	--
2011	296	83.0	11	76	98.5	25
2012	422	80.0	13	86	97.5	31
2013	576	81.0	12	70	100.5	35
2014	584	79.0	14	31	125.0	39
2015	620	76.0	12	34	119.0	42
2016	726	74.0	9	18	146.5	44
2017	706	75.0	7	8	190.5	46

-- No data available

Among those arriving to the hospital via ambulance, the median time from FMC to primary PCI was higher for transfer cases than for directly-admitted cases.

Figure 23 shows the median time from FMC to balloon time for directly-admitted cases arriving by ambulance to a STEMI receiving hospital, by setting (urban/rural). Rural areas had a higher median time from FMC to primary PCI as compared to urban areas.

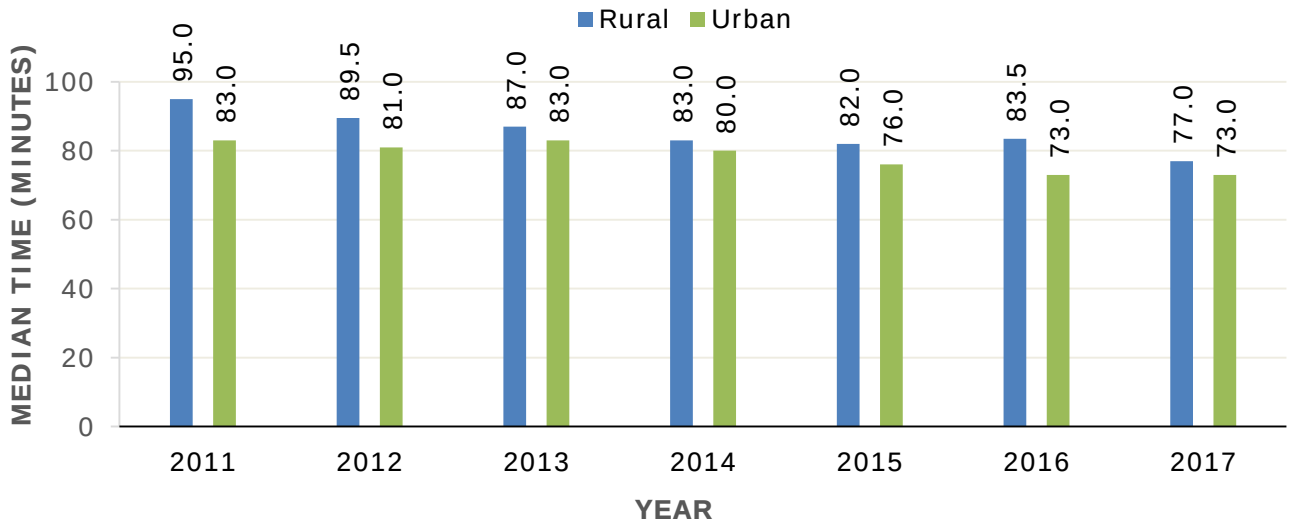

Figure 23: Median time (minutes) from first medical contact to balloon times in directly-admitted STEMI cases arriving by ambulance to receiving hospital, by setting (urban vs. rural), 2011-2017.

TOTAL ISCHEMIC TIME AMONG STEMI TRANSFER CASES

According to a 2015 study, "ischemic time is a better predictor than door-to-balloon time for mortality and infarct size in (STEMI)" patients. [7] The study suggests that the focus of STEMI care should be directed to reducing the ischemic time rather than door-to-balloon time. This can be achieved by early initiation of therapy. Figure 24 and Table 24, below, display the total ischemic time among STEMI transfer cases from 2011 to 2017, by three categories of ischemic time: less than 120 minutes, 120–239 minutes, and 240 minutes or more.

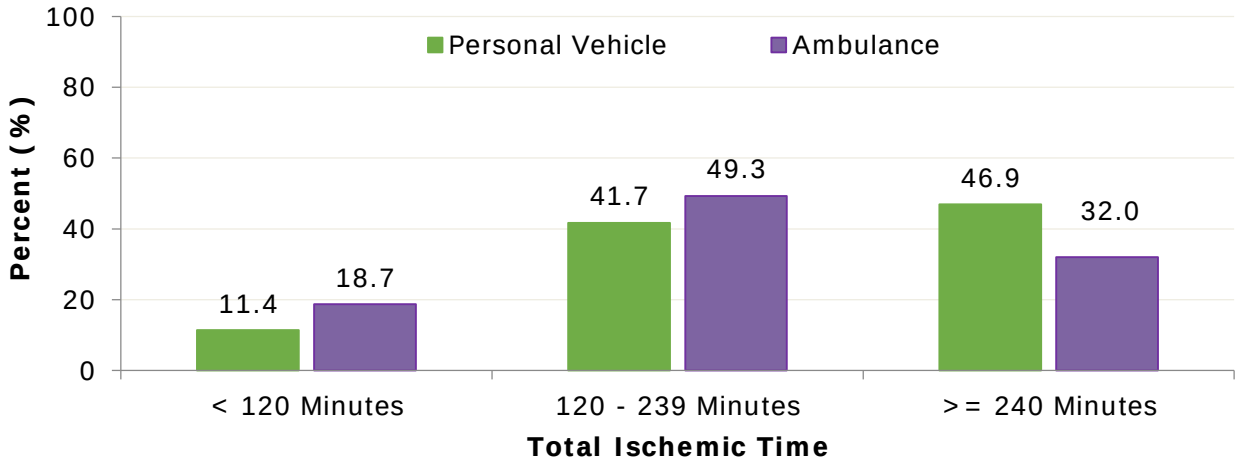

Figure 24: Total ischemic time (minutes) among STEMI transfer cases, by mode of arrival to first hospital, 2011-2017.

Table 24: Total ischemic time among STEMI transfer cases, by mode of arrival to first hospital, 2011-2017.

	Mode of arrival to STEMI referral hospital						
	Personal vehicle			Ambulance			
	Total Ischemic Time			Total Ischemic Time			
	< 120 Minutes n (%)	120-239 Minutes n (%)	≥ 240 Minutes n (%)	< 120 Minutes n (%)	120-239 Minutes n (%)	≥ 240 Minutes n (%)	Reporting hospitals (n)
Transfer cases	142 (11.4)	520 (41.7)	585 (46.9)	56 (18.7)	148 (49.3)	96 (32.0)	40

The best clinical outcomes were observed in cases with a total ischemic time <120 minutes. Total ischemic time <120 minutes was more common among those who arrived at the STEMI referral hospital by ambulance (18.7%) than by personal vehicle (11.4%). Nearly half (46.9%) of transfer cases arriving at the STEMI referral hospital by personal vehicle had a total ischemic time of 240 minutes or more, as compared with one-third (32.0%) arriving by ambulance.

TOTAL ISCHEMIC TIME AMONG STEMI DIRECTLY-ADMITTED CASES

Figures 25-27 and Table 25 display the total ischemic time among STEMI cases from 2011 to 2017, by three categories of ischemic time: <120 minutes, 120 – 239 minutes, and >=240 minutes. The best clinical outcomes are observed in those who have total ischemic time <120 minutes. [7]

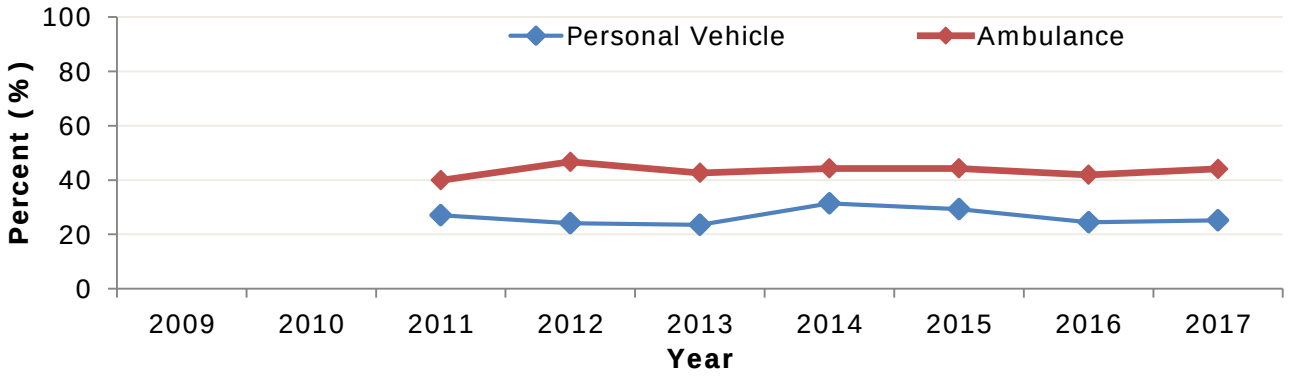

Figure 25: Total ischemic time <120 minutes among directly-admitted STEMI cases, by mode of arrival, by year, 2009-2017.

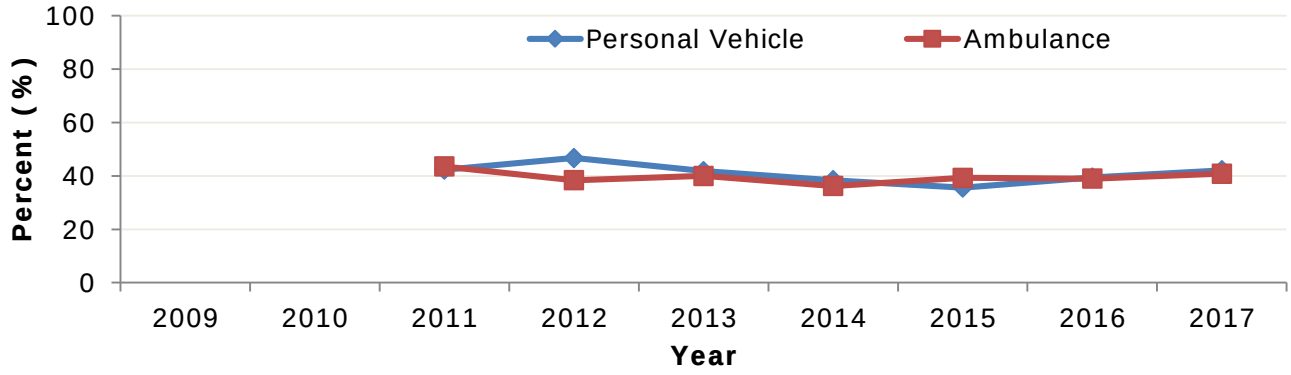

Figure 26: Total ischemic time 120 - 239 minutes among directly-admitted STEMI cases, by mode of arrival, by year, 2009-2017.

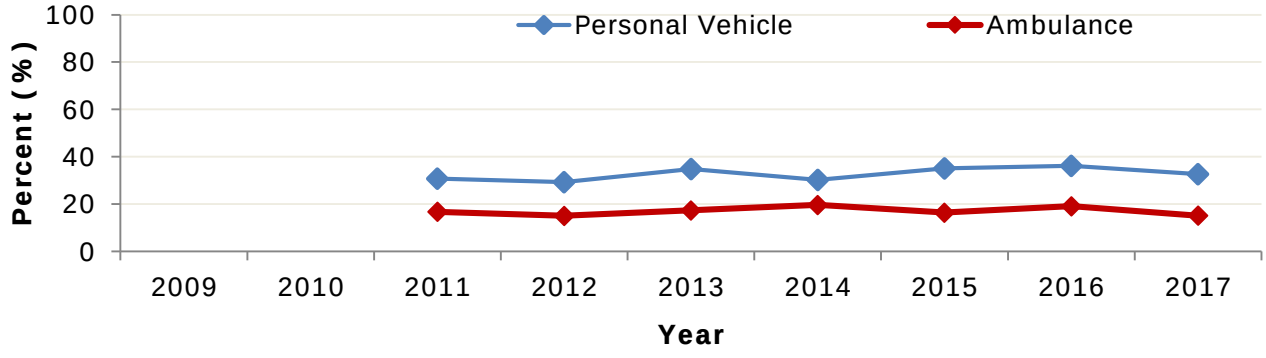

Figure 27: Total ischemic time ≥ 240 minutes among directly-admitted STEMI cases, by mode of arrival, by year, 2009-2017.

Figure 25 shows that, from 2011 to 2017, total ischemic time <120 minutes was more common among directly-admitted STEMI cases who arrived at the receiving hospital by ambulance than by personal vehicle. Figure 26 shows that there is very little difference in the number of directly-admitted STEMI cases with an ischemic time of 120-239 minutes by mode of hospital arrival. Figure 27 shows that, from 2011 to 2017, total ischemic time >=240 minutes was more common among directly-admitted STEMI cases arriving by personal vehicle than by ambulance.

Table 25: Total ischemic time among directly-admitted STEMI cases, by mode of arrival, by year, 2009-2017.

	Mode of arrival to STEMI receiving hospital						
	Personal vehicle			Ambulance			
	Total Ischemic Time			Total Ischemic Time			
Year	< 120 Minutes, n (%)	120-239 Minutes, n (%)	≥ 240 Minutes, n (%)	< 120 Minutes, n (%)	120-239 Minutes, n (%)	≥ 240 Minutes, n (%)	Reporting Hospitals (n)
2009	--	--	--	--	--	--	--
2010	--	--	--	--	--	--	--
2011	65 (27.0)	102 (42.3)	74 (30.7)	110 (39.9)	120 (43.5)	46 (16.7)	27
2012	83 (24.1)	161 (46.7)	101 (29.3)	181 (46.7)	149 (38.4)	58 (15.0)	32
2013	83 (23.5)	148 (41.8)	123 (34.8)	231 (42.6)	217 (40.0)	94 (17.3)	34
2014	138 (31.4)	169 (38.4)	133 (30.2)	224 (44.3)	183 (36.2)	99 (19.6)	40
2015	136 (29.3)	165 (35.6)	163 (35.1)	246 (44.3)	218 (39.3)	91 (16.4)	44
2016	129 (24.5)	207 (39.4)	190 (36.1)	279 (41.9)	260 (39.0)	127 (19.1)	47
2017	135 (25.2)	225 (42.1)	175 (32.7)	278 (44.1)	257 (40.8)	95 (15.1)	48

-- No data available

In 2017, 25.2% of directly-admitted STEMI cases who arrived at the hospital by personal vehicle and 44.1% of those arriving by ambulance had total ischemic time of <120 minutes (Table 25). Conversely, for 2017, twice as many cases who arrived at the hospital by personal vehicle had a total ischemic time >=240 minutes as compared with those arriving by ambulance (32.7% vs 15.1%, respectively).

MEDIAN TIME FROM SYMPTOM ONSET TO PRIMARY PCI IN DIRECTLY-ADMITTED AND TRANSFER STEMI CASES, 2017

In 2017, the total median time from symptom onset to PCI in directly-admitted STEMI cases was 144 minutes. The median time from symptom onset to EMS dispatch time was 37 minutes, and the time from EMS dispatch to arrival at the receiving hospital was 34 minutes. Figure 28 shows the median time STEMI cases spent in each stage, from onset of symptoms to time of PCI, for directly-admitted and for transfer STEMI cases in 2017.

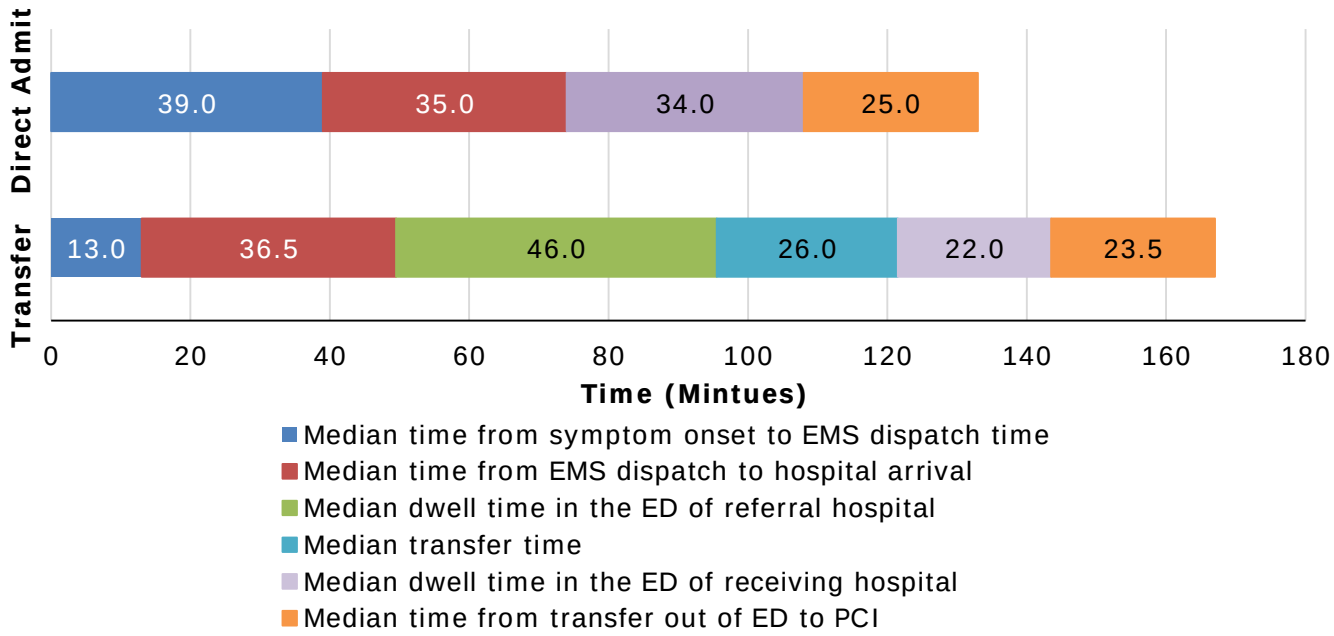

Figure 28: Median time (in minutes) from symptom onset to primary PCI, directly-admitted vs. transfer STEMI cases, 2017.

Time from symptom onset to PCI was dramatically shorter for directly-admitted vs transfer cases (median minutes of 130 vs 209, respectively). This is primarily due to the fact that directly-admitted patients have no transport time from a referral to a receiving hospital and no dwell time in a referral hospital. It should be noted that the number of STEMI cases vary for each measure in the above chart. This is due to different missing values for each variable used in calculating the measures. There were fewer than 20 cases among STEMI transfer patients for the measures “Median time from symptom onset to EMS dispatch time”, “Median time from EMS dispatch to arrival at referral hospital”, and “Transfer time”. There were more than 20 STEMI cases for all the other measures.

ACTIVATION OF CATHETERIZATION LAB PRIOR TO ARRIVAL AMONG STEMI TRANSFER CASES

Figure 29 and Table 26 show data on activation of the cardiac catheterization lab prior to patients’ hospital arrival, known as “pre-cath lab activation”, among 257 STEMI transfer cases arriving at the first hospital by personal vehicle or ambulance.

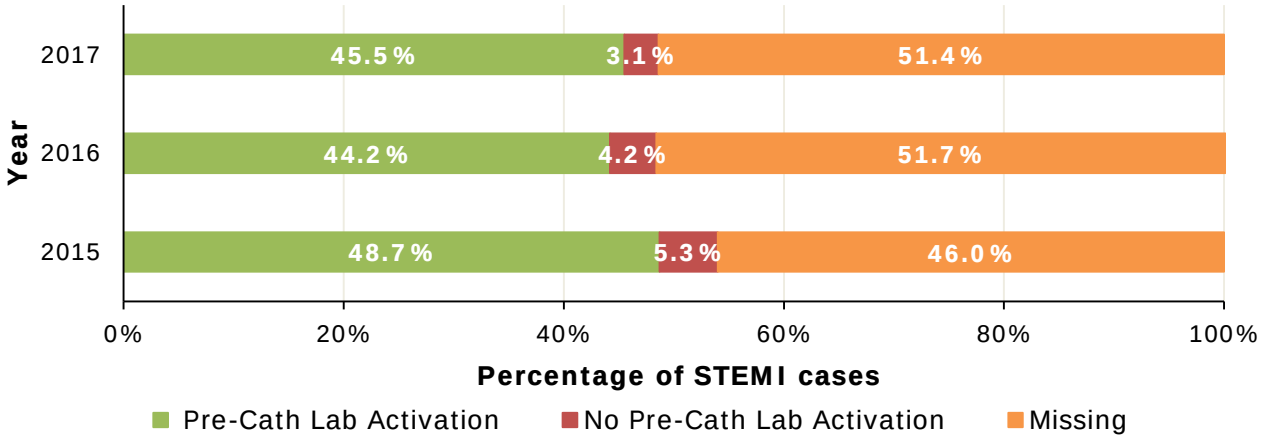

Figure 29: Percentage of pre-catheterization lab activation among STEMI transfer cases arriving to the first hospital by personal vehicle or ambulance, 2015- 2017.

Table 26: Pre-catheterization lab activation among STEMI transfer cases arriving to the first hospital by personal vehicle or ambulance, 2015-2017.

	Total STEMI cases	Pre-Cath lab activation	No Pre-Cath lab activation	Missing	Reporting Hospitals
Year	N	n (%)	n (%)	n (%)	n
2015	302	147 (48.7)	16 (5.3)	139 (46.0)	28
2016	265	117 (44.2)	11 (4.2)	137 (51.7)	33
2017	257	117 (45.5)	8 (3.1)	132 (51.4)	31

For the past three years, pre-cath lab activation has occurred for almost half of STEMI transfer patients. In 2017, the catheterization lab was activated prior to arrival at the STEMI receiving hospital for 45.5% of patients and not activated for 3.1% of patients (these do not add to 100% as data was missing for 51.4% of patients). Implementing appropriate protocols for "pre-cath lab activation" at STEMI receiving hospitals for transfer patients could reduce total ischemic time among these patients and improve outcomes.

ACTIVATION OF CATHETERIZATION LAB PRIOR TO ARRIVAL AMONG DIRECTLY-ADMITTED STEMI CASES

Figure 30 and Table 27 show data on pre-cath lab activation among 717 directly-admitted STEMI cases who arrived at the hospital by an ambulance; only cases arriving by ambulance were included because pre-cath lab activation requires notification by the EMS team.

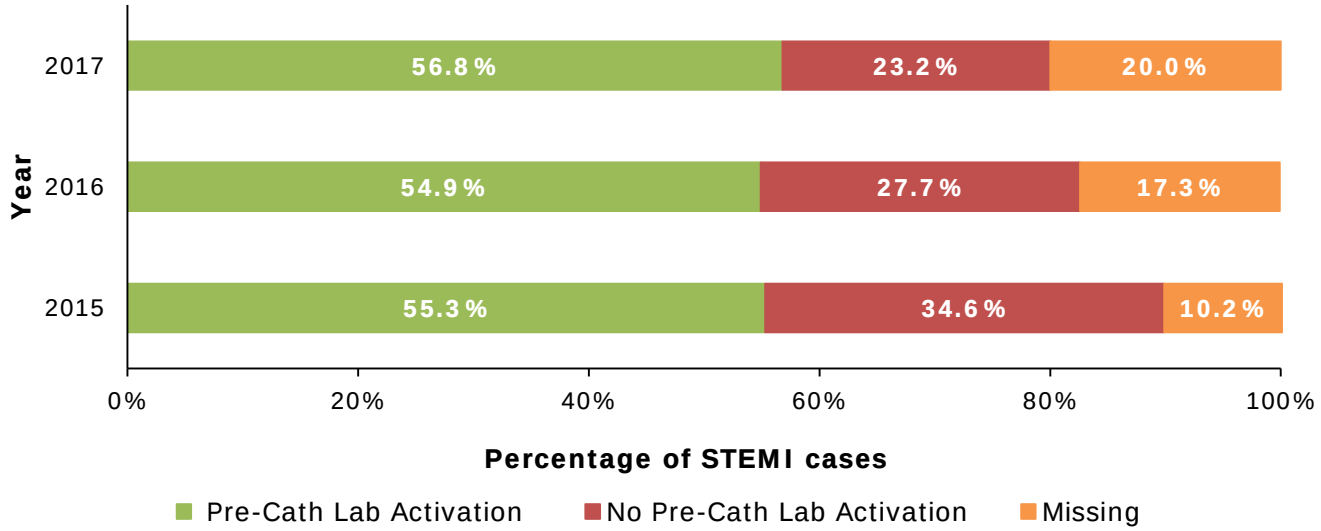

Figure 30: Pre-catheterization lab activation arrival among directly-admitted STEMI cases arriving by ambulance, 2015-2017.

Table 27: Pre-catheterization lab activation among directly-admitted STEMI cases arriving by ambulance, 2015-2017

	Total STEMI cases	Pre-Cath lab activation	No Pre-Cath lab activation	Missing	Reporting Hospitals
Year	n	n (%)	n (%)	n (%)	n
2015	628	347 (55.3)	217 (34.6)	64 (10.2)	39
2016	739	406 (54.9)	205 (27.7)	128 (17.3)	44
2017	717	407 (56.8)	166 (23.2)	144 (20.0)	44

Over the past three years, pre-cath lab activation has occurred for slightly more than half of directly-admitted STEMI cases arriving by ambulance. In 2017, pre-cath lab activation occurred for 56.8%, but not for 23.2%, of directly-admitted STEMI cases arriving by ambulance. Pre-hospital ECG within 10 minutes of FMC and accurate diagnoses of STEMI cases, when communicated to the STEMI receiving hospital, lead to greater pre-cath lab activation. Implementing standard protocols for pre-cath lab activation at STEMI receiving hospitals for patients arriving by ambulance can reduce total ischemic time and improve outcomes for these patients. Collaborative efforts between EMS providers, nursing staff, and physicians can increase pre-cath lab activation in Texas.

CARDIAC REHABILITATION REFERRAL AMONG STEMI CASES

A cardiac rehabilitation referral is defined as an official communication between the healthcare provider and the patient to recommend and carry out a referral order to an outpatient cardiac-rehabilitation program. As stated in the CDC Cardiac Rehabilitation Facts, "Comprehensive cardiac rehabilitation has been shown to reduce re-hospitalization rates, reduce recurrent sudden cardiac death, lessen the need for cardiac medications, and increase the rate of persons returning to work". [8] Figure 31 and Table 28 display 2008-2017 cardiac rehabilitation referrals among STEMI cases at time of discharge (N=17,084).

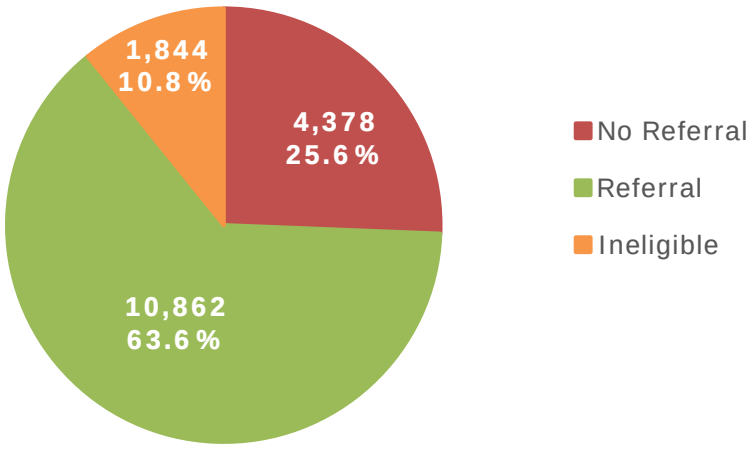

Figure 31: Cardiac rehabilitation referral among STEMI cases, 2008-2017.

Table 28: Cardiac rehabilitation referral among STEMI cases, 2008-2017.

STEMI Cases	Cardiac Rehabilitation Referral			
	Yes N (%)	No N (%)	Ineligible N (%)	Reporting Hospitals (N)
All	10,862 (63.6)	4,378 (25.6)	1,844 (10.8)	48
Female	2,817 (60.3)	1,225 (26.2)	632 (13.5)	
Male	8,045 (64.8)	3,153 (25.4)	1,212 (9.8)	

Of the total STEMI cases (N=17,084), almost two-thirds of eligible cases (n=10,862; 63.6%) were referred to a cardiac rehabilitation program, with one-fourth (25.6%) not getting referred, and the remaining cases (10.8%) being ineligible/excluded from consideration due to medical reasons, patient factors, and health care system factors. For example, a patient with a medically unstable, life-threatening condition is ineligible due to a medical reason. A patient needing to be discharged to a nursing care facility for long-term care is ineligible due to a patient factor. An example of a health care system factor is no cardiac rehabilitation program within 60 minutes from the patient's home. Recent research suggests that physician referral is the most powerful predictor for cardiac rehabilitation enrollment. [8] Appropriate measures should be taken to increase cardiac rehabilitation referral by physicians.

Cardiac rehabilitation referrals differed by gender, with a greater percentage of males (n=8,045; 64.8%) referred as compared with females (n=2,817; 60.3%).

REFERRALS FOR TOTAL MI CASES

Of the overall MI cases (N=54,606), roughly half (n=29,336; 53.7%) received referral for cardiac rehabilitation: 20,183 (68.8%) were male and 9,153 (31.2%) were female. As seen among STEMI cases, a greater percentage of male than female cases received a referral: 56.4% vs. 48.4%, respectively.

Slightly less than half of all MI cases (n=24,328; 44.6%) had Medicare insurance. Of these, almost half (n=10,206; 42.0%) had Medicare only; the remaining 58.0% had Medicare and at least one other type of insurance. Of the cases with Medicare, half (n=12,203; 50.2%) were referred to cardiac rehabilitation. Referrals did not differ whether insurance was Medicare only or Medicare plus additional insurance type(s).

VI. COMORBIDITIES AMONG MI CASES

Figure 32-34 and Table 29 show the percentages of select comorbidities among MI cases for 2008-2017. Comorbid information was missing for n=3,087 MI cases. Cases may have more than one comorbidity.

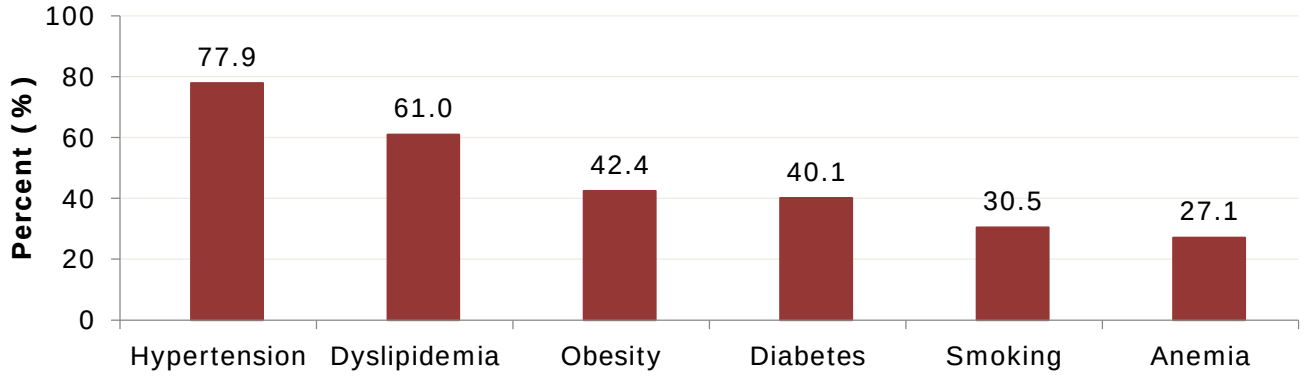

Figure 32: Percentage of select comorbidities among MI cases, 2008-2017.

Table 29: Percentage of select comorbidities among MI cases, 2008-2017.

	Select Comorbidities						Reporting Hospitals (N)
	Hypertension	Dyslipidemia	Obesity	Diabetes	Smoking	Anemia	
N	42,075	32,955	22,894	21,649	16,497	14,659	46
%	77.9	61.0	42.4	40.1	30.5	27.1	

Out of 54,040 MI cases with information on existing comorbidities (i.e., known prior to their MI), 77.9% were hypertensive, 61.0% had dyslipidemia (high cholesterol), 42.4% were obese, 40.1% had diabetes, 30.5% were current or recent smokers (within the past year),

and 27.1% were anemic. Hypertension is a very common and important risk factor for MI and efforts should be taken to reduce the prevalence of hypertension.

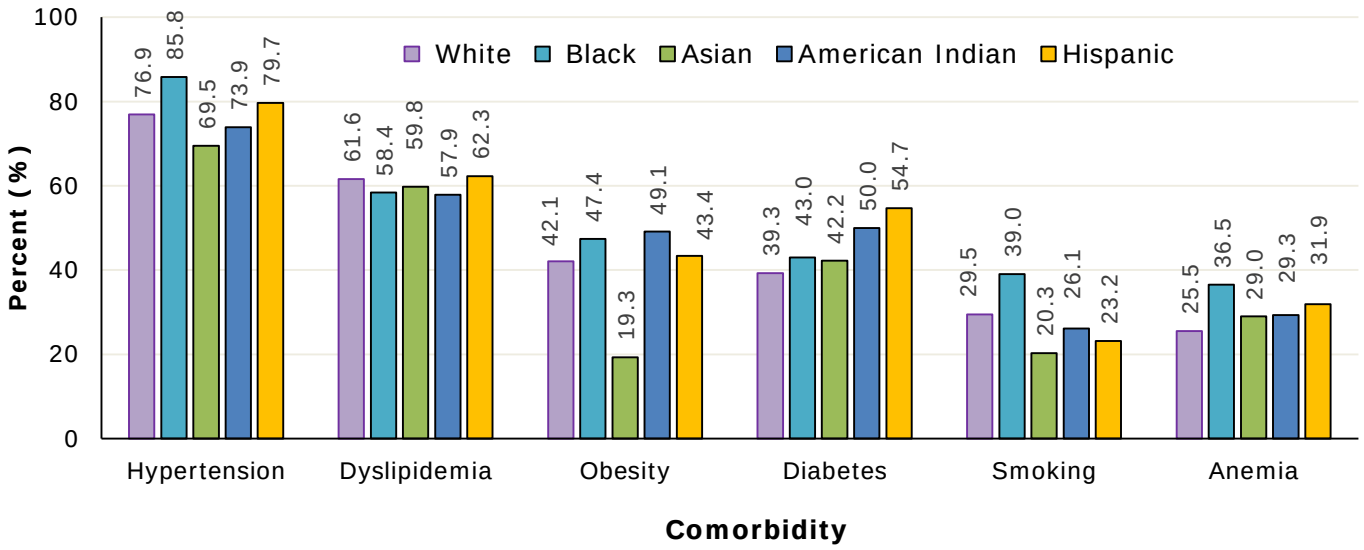

Figure 33: Percentage of select comorbidities among MI cases, by race and ethnicity, 2008-2017.

Comorbidities were further examined by race and ethnicity. Of 44,272 white MI cases, 76.9% were hypertensive, 61.6% were dyslipidemic, 42.1% were obese, 39.3% had diabetes, 29.5% were current or recent smokers, and 25.5% were anemic. Of 7,336 black MI cases, 85.8% were hypertensive, 58.4% were dyslipidemic, 47.4% were obese, 43.0% had diabetes, 39.0% were current or recent smokers, and 36.5% were anemic. Of 12,606 Hispanic MI cases, 79.7% were hypertensive, 62.3% were dyslipidemic, 43.4% were obese, 54.7% had diabetes, 23.2% were current or recent smokers, and 31.9% were anemic. Hypertension, obesity, smoking, and anemia were more common among blacks than whites or Hispanics, while diabetes was more common among Hispanics than blacks or whites. The percentages presented here are raw numbers and do not imply any statistical significance by race/ethnicity.

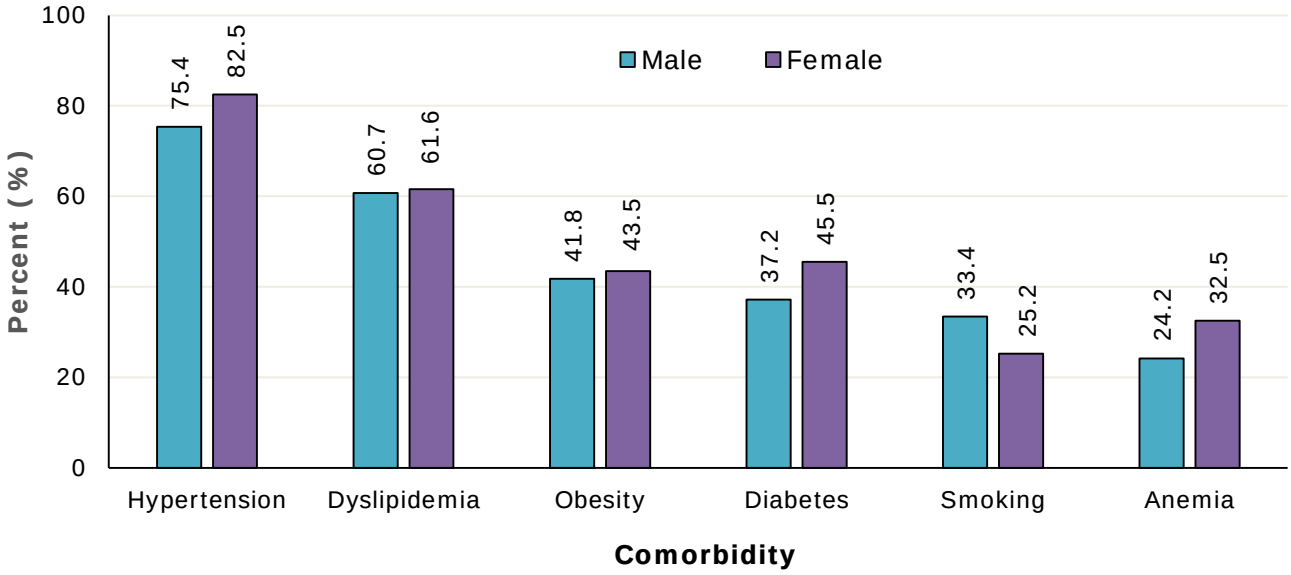

Figure 34: Percentage of select comorbidities among MI cases, by gender, 2008-2017. Among all MI patients, females appear to have a relatively higher prevalence of comorbidities as compared to males, with the exception of smoking. The percentages presented here are raw numbers and do not imply any statistical significance by gender.

SMOKING CESSATION ADVICE UPON DISCHARGE AMONG MI CASES

Smoking is a major modifiable risk factor for heart attack. Smoking increases the risk of atherosclerosis, increases the levels of triglycerides, and decreases the levels of beneficial high–density lipoprotein cholesterol (HDLc). All of these negatively impact the heart's blood flow and can thereby increase the risk of MI. [9] Smoking causes one of every three deaths from cardiovascular disease. [9] According to the World Health Organization's Tobacco Free Initiative, AMI patients who quit smoking after an episode of heart attack reduce their chance of having another heart attack by 50%. [10] From 2008-2017, of the total MI cases reported (n=57,127), almost a third (17,429) were smokers. At time of hospital discharge, 93.9% of MI cases who reported being smokers (n=16,371) were advised for smoking cessation, 2.7% (n=464) were not advised, and data were missing for 3.4% (n=594).

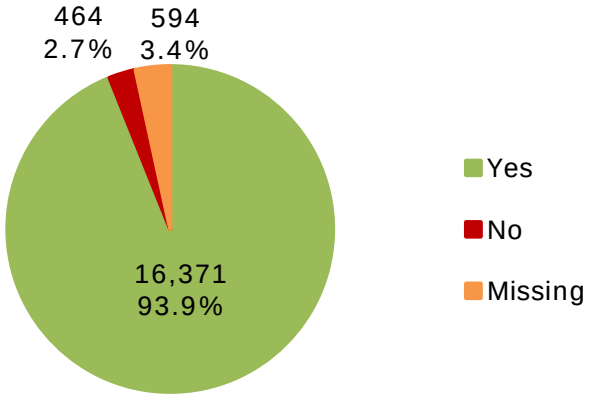

Figure 35: Smoking cessation advice given upon discharge among MI cases who were current or recent smokers, 2008-2017.

PRIOR DIABETES TREATMENT UPON ADMISSION AMONG MI CASES

Diabetes mellitus is a major public health problem, affecting an estimated 9.4% of the US population in 2015, [11] and is related to an increased risk of MI. [12] Studies show that people with diabetes are not only more likely to have an MI than someone without diabetes, but are also twice as likely to die from their MI than someone without diabetes. [13] According to some studies, the renin-angiotensin system is activated in those with diabetes, and angiotensin II inhibition has proved to be more beneficial at improving mortality rates after MI in people with versus without diabetes. [13] Along with angiotensin II antagonists, anti-hyperglycemic therapy may also improve mortality after MI in people with diabetes. [13] It was proposed in a study that Oxidized Ca^{2+}/calmodulin-dependent protein kinase II (ox-CaMKII) could be a factor responsible for mortality in MI patients with diabetes. [13] The study also suggested that CaMKII inhibition or antioxidant therapy targeted to CaMKII or mitochondria could be effective in reducing the excess mortality risk related to MI in people with diabetes. [13]

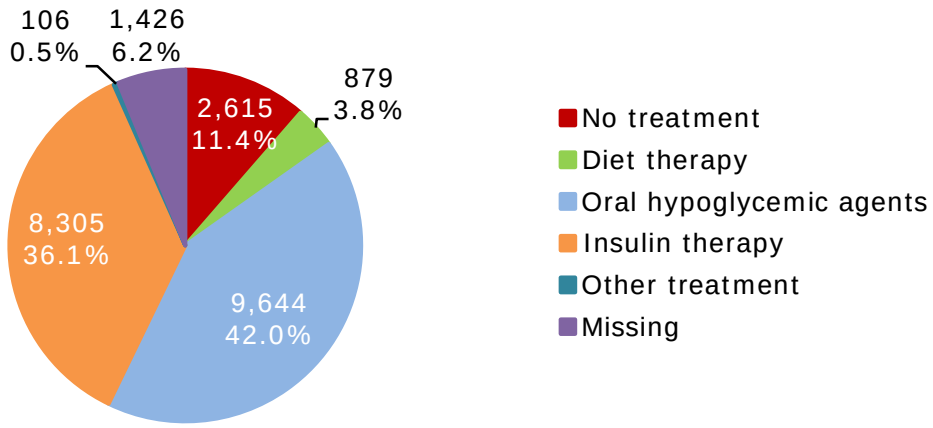

Figure 36: Diabetes treatment methods upon admission among MI cases, 2008-2017.

Between 2008 and 2017, four in ten MI cases (n=22,975, 40.2%) had a diabetes diagnosis. Upon hospital arrival for their MI, just over one in ten (11.4%) cases with diabetes were not on a plan to control their diabetes; 3.8% were on diet only treatment; 42.0% were on oral anti-hyperglycemic agents; and 36.2% were on insulin therapy. Data on this measure were missing for 6.2% of cases.

Among the MI cases with diabetes, being on no diabetes treatment was almost twice as common among of those without health insurance than those with health insurance (10.1% vs. 18.8%, respectively). This suggests that there is a gap in the treatment/management of diabetes in some MI patients, and this may have contributed to complications, including MI.

EVALUATION OF TRIGLYCERIDE LEVELS AMONG MI CASES

Hypertriglyceridemia may substantially increase cardiovascular disease risk. [14] It is recommended that patients with primary hypertriglyceridemia be evaluated for other cardiovascular risk factors such as central obesity, hypertension, liver dysfunction, and glucose metabolism abnormalities such as diabetes. [14] Normal triglyceride levels are below 150 mg/dl; levels between 150 - 199 mg/dl are considered as borderline high; levels

between 200 - 499 mg/dl are considered high; and levels of 500 mg/dl or more are considered very high. [14]

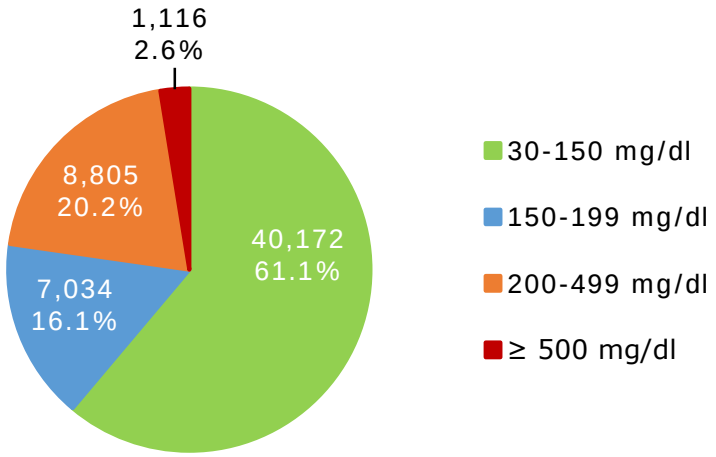

Figure 37: Triglyceride levels among MI cases, 2008-2017.

Almost two-thirds (61.1%) of the 57,127 reported MI cases from 2008-2017 had triglyceride levels within normal limits (i.e., 30 - 150 mg/dL). Of the remaining cases, 16.1% had triglyceride levels of 150 - 199 mg/dL, 20.2% of 200 - 500 mg/dL, and 2.6% had levels of 500 mg/dL or more. Cases with extremely low (0-29 mg/dL, n=214) or high (>=5000 mg/dL, n=1) were excluded from analysis. Data were missing for n=13,064 cases.

ASPIRIN ADMINISTERED WITHIN FIRST 24 HOURS OF EITHER FMC OR HOSPITAL ARRIVAL

Aspirin inhibits the enzyme cyclooxygenase I in the platelets and thereby reduces platelet aggregation. Daily aspirin therapy for the first five weeks after MI has been well established to reduce early mortality. [15]

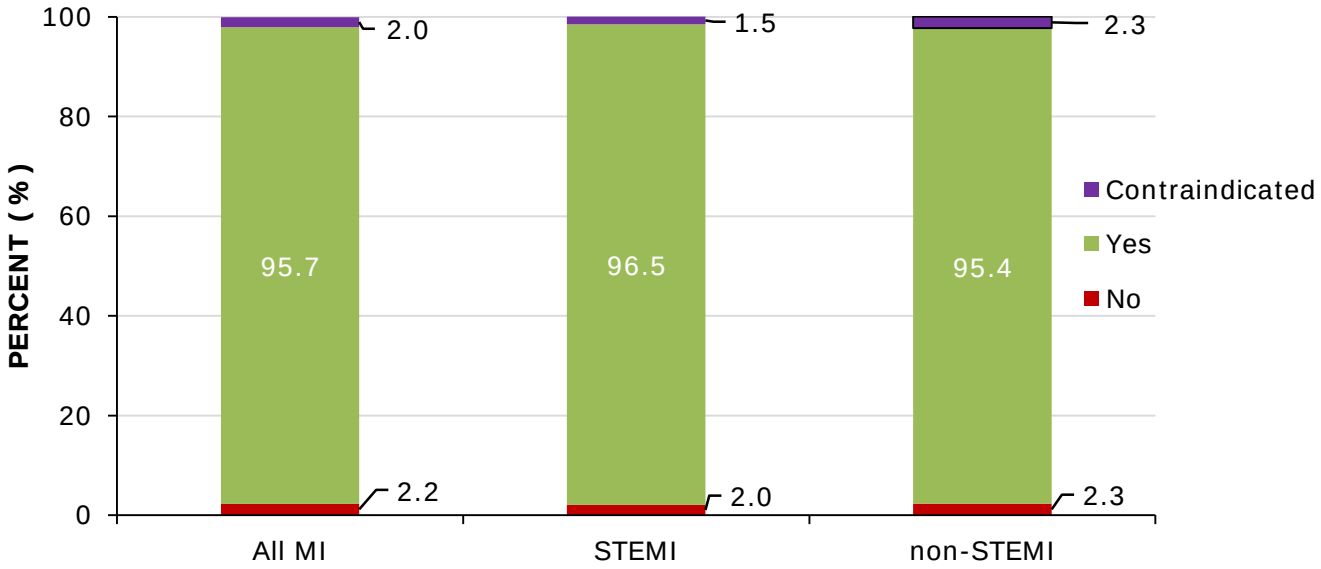

Figure 38: Aspirin administered within 24 hours of either first medical contact or hospital arrival, by MI type, 2008–2017.

Table 30. Aspirin administered within 24 hours of either first medical contact or hospital arrival, by MI type, 2008-2017 2017.

	Aspirin administered with 24 hours of hospital arrival or first medical contact			
Cases	n	Yes n (%)	No n (%)	Contraindicated n (%)
All MI	57,127	54,690 (95.7)	1,259 (2.2)	1,148 (2.0)
STEMI	18,298	17,664 (96.5)	356 (2.0)	268 (1.5)
Non-STEMI	38,829	37,026 (95.4)	903 (2.3)	880 (2.3)

Out of 57,127 MI cases reported between 2008 and 2017, almost all (95.7%) were prescribed aspirin within 24 hours of either FMC or hospital arrival. Only 2.2% did not receive this therapy, and 2.0% had contraindications to aspirin use. Data were missing for n=30 cases. The administration of aspirin within 24 hours of either FMC or hospital arrival among MI cases did not differ by sub-type (STEMI or non-STEMI). Out of 18,298 STEMI cases reported from 2008-2017, aspirin was prescribed within the first 24 hours of either FMC or hospital arrival for 96.5%, not prescribed for 2.0%, and contraindicated in 1.5%.

PRESCRIBING ASPIRIN AT DISCHARGE

As stated above, daily aspirin therapy for the first five weeks after MI has been well established to reduce mortality. [15] The following table and figure present data on this measure for all MI cases, and by MI sub-type, 2008-2017.

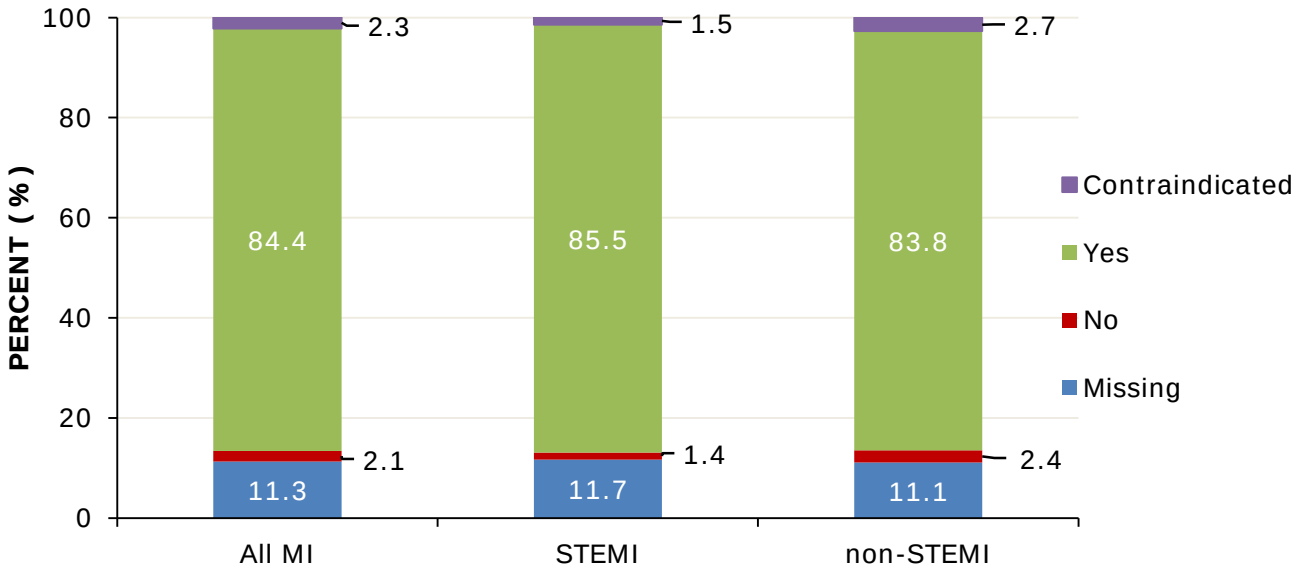

Figure 39. Aspirin prescribed at discharge, all MI and MI sub-types, 2008 -2017.

Table 31. Aspirin prescribed at discharge, all MI and MI sub-type, 2008 -2017.

		Aspirin prescribed at hospital discharge			
Cases	N	Yes n (%)	No n (%)	Contraindicated n (%)	Missing n (%)
All MI	57,127	48,191 (84.4)	1,183 (2.1)	1,316 (2.3)	6,436 (11.3)
STEMI	18,298	15,638 (85.5)	250 (1.4)	274 (1.5)	2,136 (11.7)
Non-STEMI	38,829	32,553 (83.8)	933 (2.4)	1,042 (2.7)	4,300 (11.1)

Out of 57,127 MI cases reported between 2008 and 2017, eight in ten (84.4%) were prescribed aspirin at discharge; two in 100 (2.1%) were not prescribed aspirin or had contraindication for aspirin (2.3%). Data were missing for n=6,436 (11.3%) overall MI cases. The administration of aspirin at discharge among MI patients was similar by MI sub-type (STEMI vs. non-STEMI). Out of the 18,298 STEMI cases reported, 85.5% were prescribed aspirin at discharge, 1.4% were not, and 1.5% had contraindications. Data are missing for 11.7% of STEMI cases.

PRESCRIBING BETA-BLOCKERS AT DISCHARGE

Beta-blockers may reduce mortality in MI patients. [15] These medications effectively reduce resting and exercise-induced heart rate, blood pressure, and myocardial contractility, and hence myocardial oxygen demand. They are also associated with fewer dysrhythmias, limitation of infarct size, and lower incidence of ventricular septal rupture. [15]

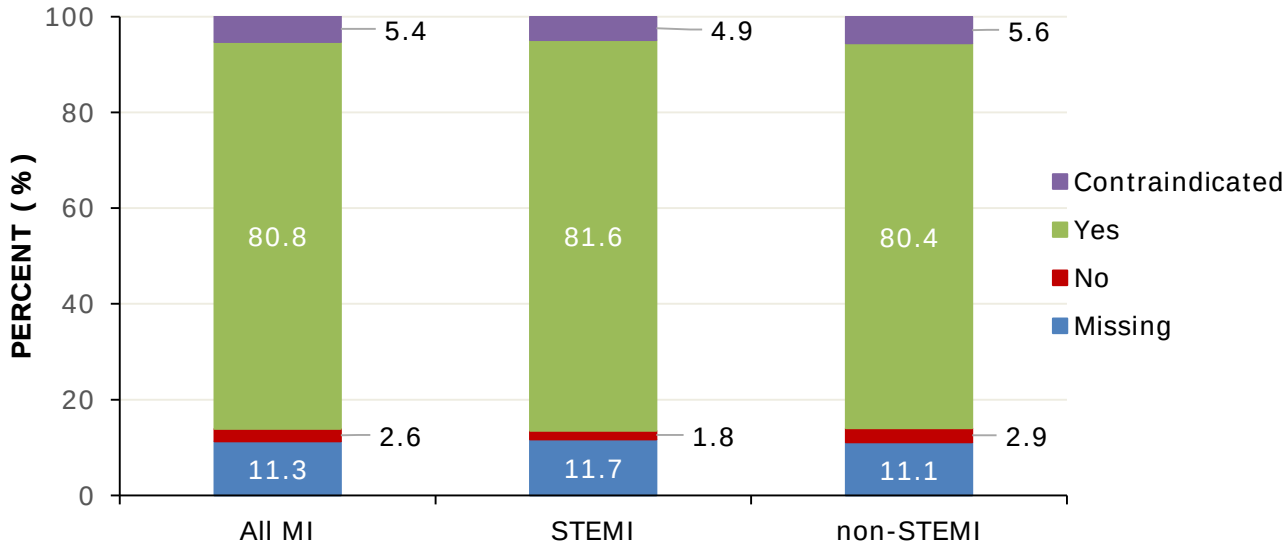

Figure 40. Beta-blockers prescribed at discharge, all MI and sub-types, 2008 -2017.

Table 32. Beta-blockers prescribed at discharge, all MI and sub-types, 2008 -2017.

		Beta-Blocker prescribed at hospital discharge			
Cases	N	Yes n (%)	No n (%)	Contraindicated n (%)	Missing n (%)
All MI	57,127	46,166 (80.8)	1,464 (2.6)	3,057 (5.4)	6,435 (11.3)
STEMI	18,298	14,939 (81.6)	334 (1.8)	888 (4.9)	2,136 (11.7)
Non-STEMI	38,829	31,227 (80.4)	1,130 (2.9)	2,169 (5.6)	4,299 (11.1)

Out of 57,127 reported cases of MI, 81 in 100 (80.8%) were prescribed beta-blockers upon hospital discharge, three in 100 (2.6%) were not prescribed beta-blockers, and five in 100 (5.4%) had contraindications for beta-blockers. Data on this measure were missing for n=6,435 (11.3%) cases. Prescribing beta-blockers at discharge did not differ by MI sub-type (STEMI vs. non-STEMI). Out of 18,298 STEMI cases reported, 81.6% were prescribed beta-blockers upon hospital discharge, 1.8% were not prescribed beta-blockers, and 4.8% had contraindications for beta-blockers. Data on this measure were missing values for 11.7% of cases.

PRESCRIBING STATINS AT DISCHARGE FOR LOW DENSITY LIPOPROTEIN CHOLESTEROL (LDLc) >= 100 MG/DL

Despite strong evidence that statin therapy confers survival benefits for post MI patients, there is limited use of lipid lowering treatment among those who meet the criteria. [15] This may be due to the concerns about financial costs related to statin use.

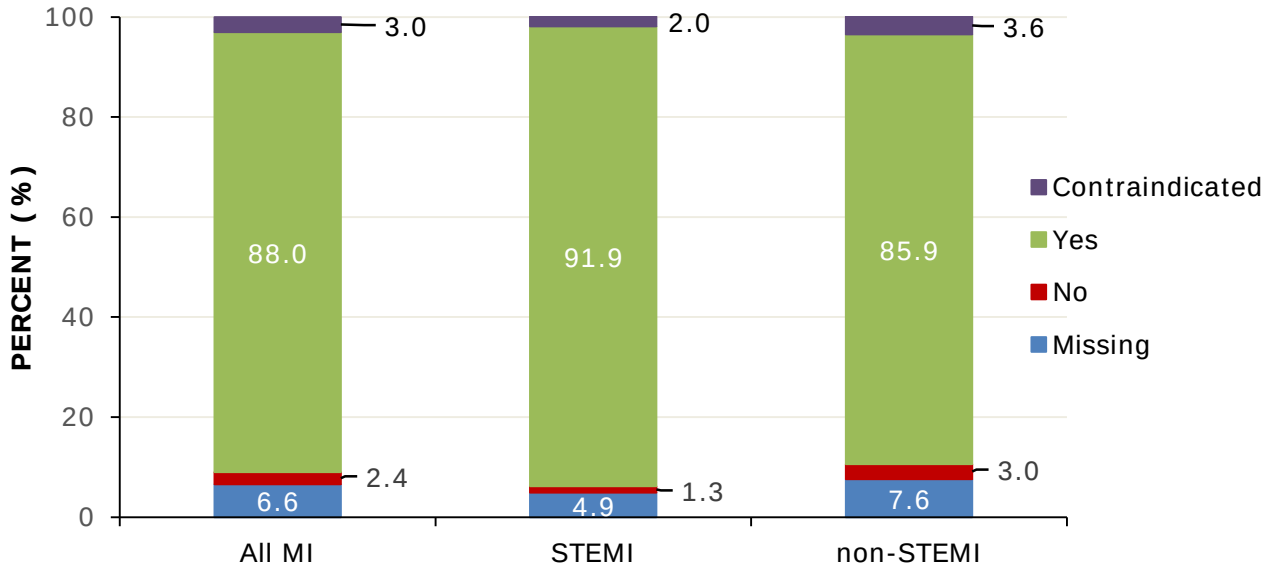

Figure 41. Statin prescribed at hospital discharge for MI cases with LDLc ≥100 mg/dl, by MI type, 2008-2017.

Table 33. Statin prescribed at hospital discharge for MI cases with LDLc ≥100 mg/dl, by MI type, 2008-2017.

		Statin prescribed at hospital discharge			
Cases	**N**	**Yes n (%)**	**No n (%)**	**Contraindicated n (%)**	**Missing n (%)**
All MI	20,548	18,091 (88.0)	487 (2.4)	611 (3.0)	1,359 (6.6)
STEMI	7,478	6,870 (91.9)	95 (1.3)	147 (2.0)	366 (4.9)
Non-STEMI	13,070	11,221 (85.9)	392 (3.0)	464 (3.6)	991 (7.6)

Out of 20,548 reported MI cases with LDLc ≥ 100 mg/dl, 88 in 100 (88.1%) were prescribed a statin upon hospital discharge, two in 100 were not (2.4%), and three in 100 (3.0%) had a contraindication for statins. Data on this measure were missing for n=1,359 (6.6%) cases. Slightly more STEMI than non-STEMI cases were prescribed statins upon hospital discharge. Out of 7,478 reported STEMI cases with LDLc ≥ 100mg/dl, 91.9% were prescribed a statin upon hospital discharge, 1.3% were not prescribed a statin, and 2.0% had contraindications for statins.

ACE INHIBITORS OR ARB AT DISCHARGE (EJECTION FRACTION, EF, < 40%)

Many studies have examined the role of Angiotensin converting enzyme (ACE) inhibitors or Angiotensin II receptor blockers (ARB) in post MI patients with reduced left ventricular function (decreased left ventricular ejection fraction, LVEF) and have found modest treatment benefits with these drugs. [15] ACE inhibitors competitively antagonize the conversion of the enzyme angiotensin I to angiotensin II and hence reduce systemic vascular resistance and cardiac afterload. [15] These drugs also reduce cardiac preload by decreasing aldosterone release and hence a reduction of circulating fluid overload. [15] They have been shown to decrease mortality rates in MI patients, and recent MI patients with left ventricular (LV) systolic dysfunction, patients with diabetes mellitus and with LV dysfunction, and also patients with normal LV function. [6] ARBs are prescribed for MI patients who have adverse effects with ACE inhibitors.

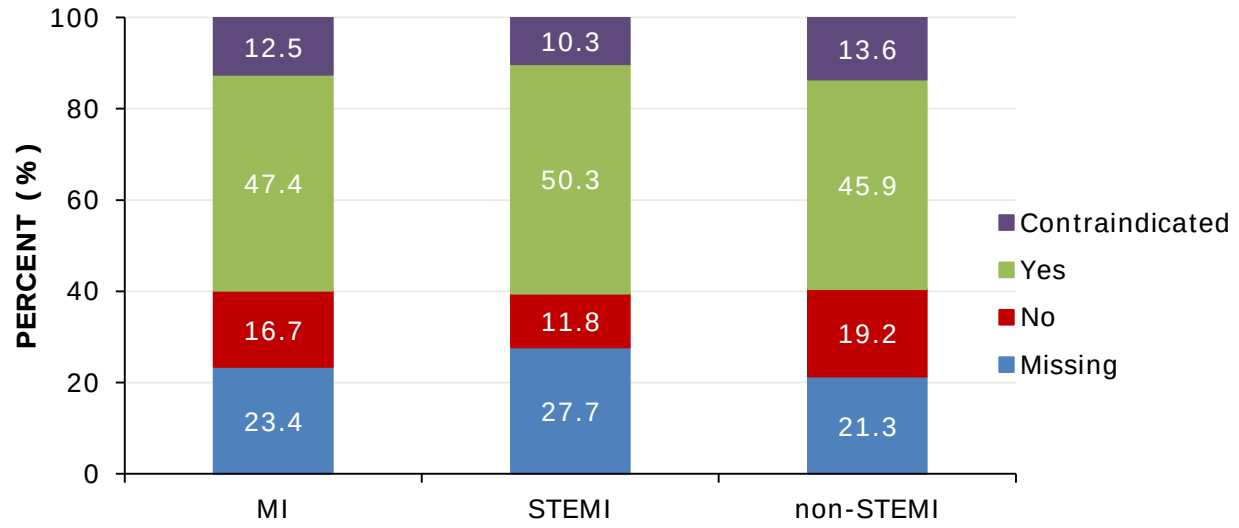

Figure 42. ACE Inhibitor prescribed at hospital discharge for MI cases with LVEF <40%, 2008-2017.

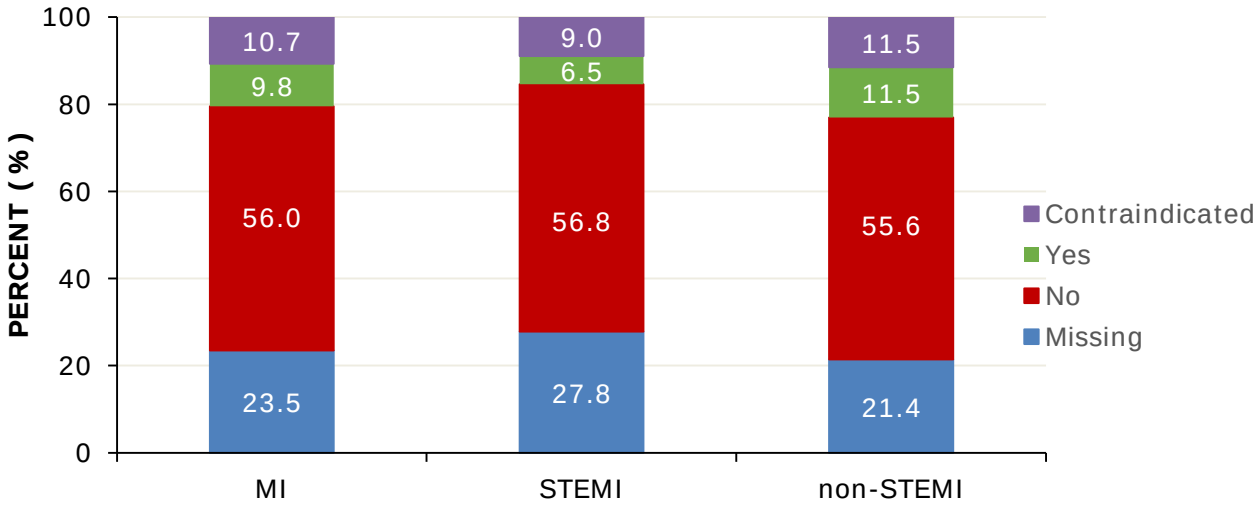

Figure 43. ARB prescribed at hospital discharge for MI cases with LVEF <40%, 2008-2017.

Table 34. ACE inhibitor or ARB prescribed at hospital discharge for MI cases with LVEF <40%, 2008-2017.

		ACE Inhibitor (ACEI) or ARB prescribed at hospital discharge							
		Yes n (%)		No n (%)		Contraindicated n (%)		Missing n (%)	
Cases	N	ACEI	ARB	ACEI	ARB	ACEI	ARB	ACEI	ARB
ALL MI	15,704	7,436 (47.4)	1,541 (9.8)	2,628 (16.7)	8,795 (56.0)	1,959 (12.5)	1,680 (10.7)	3,681 (23.4)	3,688 (23.5)
STEMI	5,197	2,614 (50.3)	337 (6.5)	612 (11.8)	2,950 (56.8)	533 (10.3)	469 (9.0)	1,438 (27.7)	1,441 (27.8)
Non-STEMI	10,507	4,822 (45.9)	1,204 (11.5)	2,016 (19.2)	5,845 (55.6)	1,426 (13.6)	1,211 (11.5)	2,243 (21.3)	2,247 (21.4)

Of 15,704 reported MI cases with LVEF <40%, almost half (47.4%) were prescribed ACE inhibitors upon hospital discharge, 17 in 100 (16.7%) were not prescribed ACE inhibitors, and 12 in 100 (12.5%) had a contraindication. Data on this measure were missing for 23.4% of cases. The prescription of ACE inhibitors at discharge among MI cases varied slightly by STEMI vs non-STEMI, with more STEMI cases being prescribed ACE inhibitors than non-STEMI cases. Out of 5,197 reported STEMI cases with LVEF <40%, half (50.3%) were prescribed an ACE inhibitor upon hospital discharge, 12 in 100 (11.8%) were not prescribed an ACE inhibitor, and 10 in 100 (10.3%) had a contraindication for ACE inhibitors. Data on this measure were missing for 27.8% of cases.

At time of hospital discharge, ARBs were prescribed to 10 in 100 (9.8%) of the 15,704 MI cases with LVEF <40% and to 7 in 100 (6.5%) of STEMI cases. The prescription of ARBs at discharge among MI cases varied slightly by MI sub-type, with ARBS prescribed almost twice as frequently to non-STEMI than to STEMI cases (11.5% vs 6.5%, respectively).

LDL ASSESSMENT

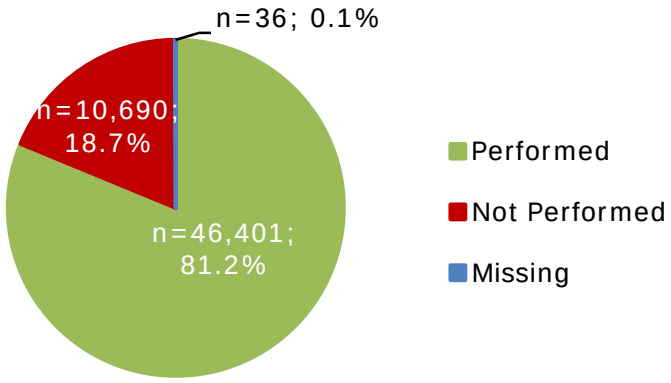

Figure 44: Low density lipoprotein cholesterol (LDLc) assessment among MI cases, 2008-2017.

Of the 57,127 reported MI cases between 2008 and 2017, eight in ten (81.2%) had a lipid (total lipids and LDLc) panel assessment, but this was not performed in the remaining 18.7%. Out of 18,298 STEMI cases reported over the same period, LDLc assessment was done in a similar number of cases (83.2%).

VII. UNADJUSTED IN-HOSPITAL MORTALITY RATES

The table and figure shown below display the unadjusted in-hospital mortality rates for MI cases (overall and by sub-type) between 2008 and 2017.

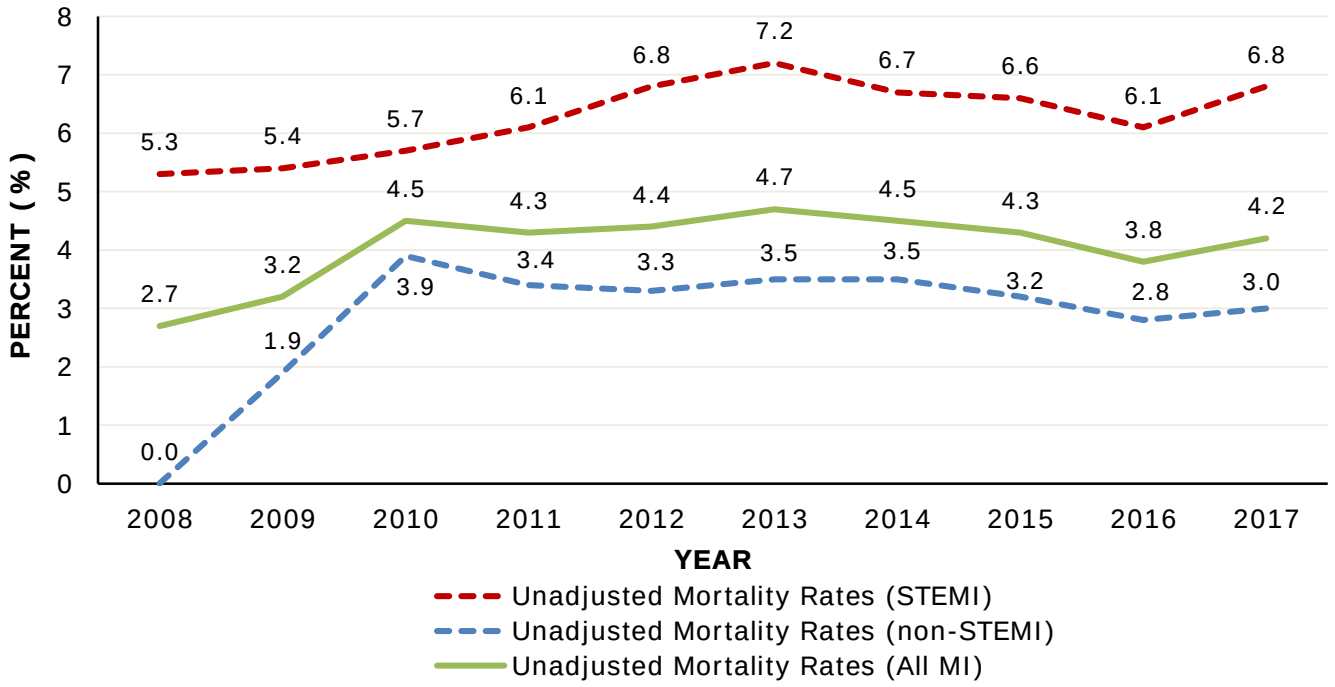

Figure 45. Unadjusted in-hospital mortality rates among STEMI, non-STEMI, and all MI cases, 2008-2017.

Table 35. Unadjusted in-hospital mortality rates among STEMI, non-STEMI, and all MI cases, 2008–2017.

Year	STEMI cases n	In-hospital deaths n (%)	Non-STEMI cases n	In-hospital deaths n (%)	All MI cases n	In- hospital deaths n (%)
2008	57	3 (5.3)	54	0 (0.0)	111	3 (2.7)
2009	296	16 (5.4)	516	10 (1.9)	812	26 (3.2)
2010	1,162	66 (5.7)	2,182	84 (3.9)	3,344	150 (4.5)
2011	1,805	110 (6.1)	3,443	116 (3.4)	5,248	226 (4.3)
2012	2,015	137 (6.8)	4,432	148 (3.3)	6,447	285 (4.4)
2013	2,261	162 (7.2)	4,673	163 (3.5)	6,934	325 (4.7)
2014	2,401	160 (6.7)	5,387	188 (3.5)	7,788	348 (4.5)
2015	2,630	173 (6.6)	5,705	182 (3.2)	8,335	355 (4.3)
2016	2,914	177 (6.1)	6,392	180 (2.8)	9,306	357 (3.8)
2017	2,757	188 (6.8)	6,045	183 (3.0)	8,802	371 (4.2)

The mortality rates range from as low as 5.3% in 2008 to as high as 7.2% in 2013 among STEMI patients. Among non-STEMI patients, the mortality rates range from as low as 0% in 2008 to as high as 3.9% in 2010. Since 2011, the unadjusted in-hospital mortality rates for STEMI patients have been roughly twice as high as for non-STEMI patients. Note: Care should be taken when interpreting rates from 2008, which are based only on three months of data (4th quarter).

APPENDIX – DATA SOURCES AND DEFINITIONS

Glossary

- ***First hospital*** refers to the facility where a patient is initially seen.
- ***STEMI referral hospital*** refers to a facility where a patient is initially seen and from which the patient is transferred to a STEMI receiving facility. All STEMI referral hospitals are considered **first hospitals**.
- ***STEMI receiving hospital*** refers to a facility to which a patient is transferred after being initially seen at a non-PCI-capable hospital or STEMI referral hospital.
- ***Directly-admitted patient*** refers to a STEMI patient first presents to a STEMI receiving hospital or PCI-capable hospital, bypassing a STEMI referral hospital.
- ***Transfer patient*** refers to a STEMI patient who first presents at a STEMI referral hospital and requires transfer to a STEMI receiving hospital.

Table 1 (pg. 8)

Data Source: Texas Behavioral Risk Factor Surveillance System Public Use Data File, 2011-16. Texas Department of State Health Services, Center for Health Statistics, Austin, Texas.

Table 2 (pg. 8)

Data Sources: Texas Hospital Inpatient Discharge Public Use Data File, 2008-16. Texas Department of State Health Services, Center for Health Statistics, Austin, Texas; and County-Level Population Data, 2008-16. Texas Department of State Health Services, Center for Health Statistics, Austin, Texas.

Prior to September 2015, hospitalization rates were based on hospital records for which acute myocardial infarction was coded as the principal diagnosis, using International Classification of Diseases, Ninth Revision, Clinical Modification **(ICD-9-CM)** codes 410.00-410.01, 410.10-410.11, 410.20-410.21, 410.30-410.31, 410.40-410.41, 410-.50-410.51, 410.60-410.61, 410.70-410.71, 410.80-410.81, 410.90-410.91, a classification defined in the Specifications Manual for National Hospital Inpatient Quality Measures. Records from September 2015 forward are based on **ICD-10** codes I21-22. Excludes records for HIV and drug/alcohol use patients and non-residents hospitalized in-state. Population estimates were generated using the 2000 Projected U.S. Standard Population for age-adjustment and the following age-adjustment groups: 0-4, 5-9, 10-14, 15-34, 35-64, 65+.

Figure 1 (pg.9)

Data Sources: County-Level Mortality Data, 2009-15. Texas Department of State Health Services, Center for Health Statistics, Austin, Texas; and County-Level Population Data, 2009-15. Texas Department of State Health Services, Center for Health Statistics, Austin, Texas.

Mortality rates were based on death records for which heart attack was coded as the underlying cause of death, using International Classification of Diseases, Tenth Revision (ICD-10) codes I21-I22; and generated using the 2000 U.S. Standard Population for age-adjustment and the following age-adjustment groups: 0, 1-4, 5-14, 15-24, 25-34, 35-44, 45-54, 55-64, 65-74,75+

Figure 2 (pg. 10)

Source: Bates, E.R. and Jacobs, A.K. (2013). Time to treatment in patients with STEMI. *The New England Journal of Medicine, 369* (10), 889-892.

PRE-HOSPITAL ECG WITHIN 10 MINUTES OF FIRST MEDICAL CONTACT (pg. 16-17)

Definition

Time to pre-hospital ECG was estimated by measuring the time elapsed from first medical contact (when the patient was first evaluated by either emergency medical services or another healthcare provider prior to arrival at the hospital) to receipt of first ECG among patients arriving at the hospital by ambulance and receiving their first ECG prior to arrival at the hospital.

Population excludes patients:

- <18 years old
- Arriving at STEMI receiving hospital via personal vehicle, mobile ICU, or air
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Receiving first ECG after arrival at STEMI receiving hospital
- Receiving first ECG>24 hours after first medical contact
- With incomplete records—i.e., records with missing data for any variable used to define the population

TIME FROM HOSPITAL ARRIVAL TO FIRST ECG AMONG TRANSFER CASES (pg. 17-18)

Definition

Time to ECG was estimated by measuring the time elapsed from arrival at a STEMI referral hospital to receipt of first ECG. Thus, for episodes of care involving patients received as transfers at the STEMI receiving hospital, the date and time of arrival at the STEMI referral hospital, as documented by the STEMI receiving hospital, was used to clock time to ECG.

Population excludes patients:

- <18 years old
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Receiving first ECG before arrival at STEMI referral hospital, e.g., while in transit in an ambulance
- Receiving first ECG>24 hours after arrival at STEMI referral hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

TIME FROM HOSPITAL ARRIVAL TO FIRST ECG AMONG DIRECTLY-ADMITTED CASES (pg.19)

Definition

Time to ECG was estimated by measuring the time elapsed from arrival at the STEMI receiving hospital to receipt of first ECG.

Population excludes patients:

- <18 years old
- Arriving at STEMI receiving hospital via mobile ICU or air
- Received as transfer from STEMI referral hospital to STEMI receiving hospital

- Receiving first ECG before arrival at STEMI receiving hospital, e.g., while in transit in an ambulance
- Receiving first ECG>24 hours after arrival at STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

HOSPITAL ECG WITHIN 10 MINUTES OF ARRIVAL AMONG TRANSFER CASES (pg. 20-21)

Definition

Time to ECG was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to receipt of first ECG. Thus, for episodes of care involving patients received as transfers at a STEMI receiving hospital, the date and time of arrival at the transferring hospital, as documented by the STEMI receiving hospital, was used to clock time to ECG.

Population excludes patients:

- <18 years old
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Receiving first ECG before arrival at STEMI referral hospital, e.g., while in transit in an ambulance
- Receiving first ECG>24 hours after arrival at STEMI referral hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

HOSPITAL ECG WITHIN 10 MINUTES OF ARRIVAL AMONG DIRECTLY-ADMITTED CASES (pg. 21 -22)

Definition

Time to ECG was estimated by measuring the time elapsed from arrival at the STEMI receiving hospital to receipt of first ECG.

Population excludes patients:

- <18 years old
- Arriving at STEMI receiving hospital via mobile ICU or air
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Receiving first ECG before arrival at STEMI receiving hospital, e.g., while in transit in an ambulance
- Receiving first ECG>24 hours after arrival at STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

DWELL TIME IN THE EMERGENCY DEPARTMENT OF REFERRAL HOSPITAL (pg. 22-23)

Definition

Dwell time in the emergency department was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to discharge at the STEMI referral hospital.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack

- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Not first evaluated in the emergency department of STEMI referral hospital
- Not discharged and transferred to another hospital for PCI
- Transferred >24 hours after arrival at STEMI referral hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

DWELL TIME IN THE EMERGENCY DEPARTMENT OF RECEIVING HOSPITAL AMONG TRANSFER CASES (pg. 23 - 24)

Definition

Time spent in the emergency department was estimated by measuring the time elapsed from arrival at the STEMI receiving hospital to transfer out of the emergency department of the STEMI receiving hospital. Thus, for episodes of care involving patients received as transfers at the STEMI receiving hospital, the time elapsed reflects wait time at the subsequent hospital and not at the STEMI referral hospital.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Not first evaluated in the emergency department of STEMI receiving hospital
- Spending >24 hours in the emergency department of STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

DWELL TIME IN THE EMERGENCY DEPARTMENT OF RECEIVING HOSPITAL AMONG DIRECTLY-ADMITTED CASES (pg. 24 - 25)

Definition

Time spent in the emergency department was estimated by measuring the time elapsed from arrival at the STEMI receiving hospital to transfer out of the emergency department of the STEMI receiving hospital.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Not first evaluated in the emergency department of STEMI receiving hospital
- Spending >24 hours in the emergency department of STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

FIRST DOOR-TO-NEEDLE TIME (pg. 25-26)

Definition

Door to needle time was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to receipt of fibrinolytic therapy at the STEMI referral hospital. For episodes of care involving patients received as transfers at the STEMI receiving hospital, the date and time of arrival at the STEMI referral hospital, as documented by the STEMI receiving hospital, was used to clock door to needle time.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Receiving percutaneous coronary intervention for reperfusion therapy
- With a non-system reason for delay of fibrinolysis
- Receiving fibrinolysis >6 hours after arrival at STEMI referral hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

DOOR-TO-NEEDLE TIME WITHIN 30 MINUTES AMONG TRANSFER CASES (pg. 26-27)

Definition

Door to needle time was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to receipt of fibrinolytic therapy at the STEMI referral hospital. For episodes of care involving patients received as transfers at the STEMI receiving hospital, the date and time of arrival at the STEMI referral hospital, as documented by the STEMI receiving hospital, was used to clock door to needle time.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Receiving percutaneous coronary intervention for reperfusion therapy
- With a non-system reason for delay of fibrinolysis
- Receiving fibrinolysis >6 hours after arrival at STEMI referral hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

DOOR-TO-BALLOON TIME FOR DIRECTLY-ADMITTED CASES (pg. 27-28)

Definition

Door to balloon time was estimated by measuring the time elapsed from arrival at the hospital to receipt of primary percutaneous coronary intervention.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack

- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after arrival at STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

DOOR-TO-BALLOON TIME WITHIN 90 MINUTES FOR DIRECTLY-ADMITTED CASES (pg. 28 - 29)

Definition

Door to balloon time was estimated by measuring the time elapsed from arrival at the STEMI receiving hospital to receipt of primary percutaneous coronary intervention.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after hospital arrival at STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

FIRST DOOR-TO-BALLOON TIME FOR TRANSFER CASES (pg. 29 -30)

Definition

Time from first door to balloon was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to receipt of primary percutaneous coronary intervention at the STEMI receiving hospital. For episodes of care involving patients received as transfers at the STEMI receiving hospital, the date and time of arrival at the STEMI referral hospital, as documented by the STEMI receiving hospital, was used to clock first door to balloon time.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after arrival at STEMI referral hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

FIRST DOOR-TO-BALLOON TIME WITHIN 120 MINUTES FOR TRANSFER CASES (pg.30 -31)

Definition

Time from first door to balloon was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to receipt of primary percutaneous coronary intervention at the STEMI receiving hospital. For episodes of care involving patients received as transfers at the STEMI receiving hospital, the date and time of arrival at the STEMI referral hospital, as documented by the STEMI receiving hospital, was used to clock first door to balloon time.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after arrival at STEMI referral hospital
- With incomplete records – i.e., records with missing data for any variable used to define the population.

FIRST DOOR-TO-BALLOON TIME WITHIN 90 MINUTES FOR TRANSFER CASES (pgs.31 -32)

Definition

Time from first door to balloon was estimated by measuring the time elapsed from arrival at the STEMI referral hospital to receipt of primary percutaneous coronary intervention at the STEMI receiving hospital.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after arrival at STEMI referral hospital
- With incomplete records – i.e., records with missing data for any variable used to define the population.

FIRST MEDICAL CONTACT TO BALLOON TIME (pgs. 32-33)

Definition

Time from the first medical contact by EMS to the primary percutaneous coronary intervention in both transfer and directly admitted patients is referred as first medical contact to balloon time.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after arrival at STEMI referral hospital
- With incomplete records – i.e., records with missing data for any variable used to define the population.

TOTAL ISCHEMIC TIME AMONG STEMI TRANSFER CASES (pg. 34)

Definition

Ischemic Time was estimated by measuring the time from symptom onset to receipt of primary percutaneous coronary intervention at the STEMI receiving hospital.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Directly admitted to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after hospital arrival at STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

TOTAL ISCHEMIC TIME AMONG STEMI DIRECTLY-ADMITTED CASES (pgs. 34-36)

Definition

Ischemic Time was estimated by measuring the time from symptom onset to receipt of primary percutaneous coronary intervention at the STEMI receiving hospital.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Receiving percutaneous coronary intervention >24 hours after hospital arrival at STEMI receiving hospital
- With incomplete records—i.e., records with missing data for any variable used to define the population

MEDIAN TIMES FROM SYMPTOM ONSET TO PRIMARY PCI IN DIRECTLY-ADMITTED AND TRANSFER STEMI CASES (pgs. 36 -37)

Definition

The median times from the symptom onset to the primary percutaneous coronary intervention in both transfer and directly admitted patients are calculated.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI referral hospital via mobile ICU or air
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention
- Receiving percutaneous coronary intervention >24 hours after arrival at STEMI referral hospital
- With incomplete records – i.e., records with missing data for any variable used to define the population.

ACTIVATION OF CATHETERIZATION LAB PRIOR TO ARRIVAL AMONG TRANSFER CASES (pgs.37 -38)

Definition

Prehospital activation of the cardiac catheterization lab prior to arrival of transfer patients.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Directly-admitted to STEMI receiving hospital
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention

ACTIVATION OF CATHETERIZATION LAB PRIOR TO ARRIVAL AMONG DIRECTLY-ADMITTED CASES (pgs.38-39)

Definition

Prehospital activation of the cardiac catheterization lab prior to arrival of directly-admitted patients. Prehospital EKG identifies STEMI patients and assists in cardiac lab activation prior to arrival of the patients at the hospital.

Population excludes patients:

- <18 years old
- Diagnosed with non-STEMI heart attack
- Directly-admitted to STEMI receiving hospital
- Diagnosed with STEMI heart attack on subsequent ECG
- Arriving at STEMI receiving hospital via mobile ICU or air
- Received as transfer from STEMI referral hospital to STEMI receiving hospital
- Not receiving percutaneous coronary intervention as primary reperfusion therapy
- With a non-system reason for delay of percutaneous coronary intervention

CARDIAC REHABILITATION REFERRAL (pgs. 39-40)

Definition

A referral is defined as an official communication between the healthcare provider and the patient to recommend and carry out a referral order to an outpatient cardiac rehabilitation program. Many people with heart disease can benefit from cardiac rehabilitation. The purpose of cardiac rehabilitation is to reduce morbidity and mortality associated with cardiovascular illness by modifying the patient's coronary risk factors.

Population excludes patients:

- <18 years old
- With incomplete records—i.e., records with missing data for any variable used to define the population
- Deceased at discharge
- Diagnosed with non-STEMI heart attack

COMORBIDITIES AMONG MI CASES (pgs. 41-42)

Definition

The simultaneous presence of two chronic diseases or conditions in a patient. For example, the simultaneous presence of hypertension or diabetes or obesity or dyslipidemia or smoking history in a heart attack patient. According to the World Health Organization (WHO) definition, anemia is defined as a hemoglobin value <12g/dl in women and <13g/dl in men.

Population excludes patients:

- <18 years old
- With incomplete records – i.e., records with missing data for comorbidities.

SMOKING CESSATION ADVICE UPON DISCHARGE (pgs.42-43)

Definition

Smoking cessation advice or counseling given during discharge among patients who smoked cigarettes any time in the year prior to hospital arrival.

Population excludes patients:

- <18 years old
- Not reporting cigarette smoking at any time in the year prior to hospital arrival
- Deceased at discharge

PRIOR DIABETES TREATMENT UPON ADMISSION (pgs.43 - 44)

Definition

Prior anti-diabetic treatment for admitted diabetes patients of Acute Myocardial Infarction. The treatment includes diet therapy, insulin therapy or any other oral hypoglycemic drugs.

Population excludes patients:

- <18 years old

EVALUATION OF TRIGLYCERIDE LEVELS AMONG MI CASES (pg.44)

Population excludes patients:

- <18 years old

ASPIRIN ADMINISTERED WITHIN FIRST 24 HOURS (pg. 45)

Population excludes patients:

- <18 years old

ASPIRIN AT DISCHARGE (pg. 46)

Population excludes patients:

- <18 years old

BETA-BLOCKERS AT DISCHARGE (pgs. 46-47)

Population excludes patients:

- <18 years old

STATIN AT DISCHARGE FOR LDL >= 100 MG/DL (pg. 48)

Population excludes patients:

- <18 years old
- With LDL < 100 mg/dl

ACE INHIBITORS OR ARB AT DISCHARGE (LVEF <40%) (pgs. 49-51)

Population excludes patients:

- <18 years old
- With LVEF ≥ 40%

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